TARGET

DOCTOR WHO DISCOVERS

SPACE TRAVEL

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SPACE TRAVEL

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DOCTOR WHO

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INTRODUCTION

Travelling in space is very easy when you are a Time Lord. But its secrets are carefully guarded and Dr. Who is not permitted to divulge precisely how the Tardis works. Lesser mortals have to find out how to travel in space for themselves, and in this story the Doctor discovers how space travel began with the first rockets as men started on the exciting path to the planets.

When an early satellite was launched there was almost an accident since the Doctor hardly expected to find another object in orbit round the Earth. But since 1957 he has kept a careful eye on space progress and in this book you can follow the Doctor's adventures as the Tardis appears at all the important landmarks—or should it be spacemarks?—of man's efforts to explore the solar system.

The Doctor watches the Apollo II mission blast off for the Moon; after that there is the laboratory in space, the robot satellite on Mars, the shuttle that rockets into space and returns and the remarkable weather forecasting satellites sending their pictures back to Earth.

Finally the Doctor takes a trip into the future and discovers the giant colonies in space where millions of people live in artificial gravity.

As the Doctor knows, man is an inquisitive and exploring creature who will go on travelling further into space to discover more about the Universe in which he lives. The space-age is still very young; but already men have travelled millions of miles in strange and powerful machines.

IN THE BEGINNING

The Doctor, who always pretended never to be surprised by anything, had not really expected the 'space-age' on planet Earth to begin as soon as it did.

Travelling in space was all right for the Time Lords, and very necessary for sending the Doctor all over the galaxy to sort out the various problems which arose, but in less than fifty years from the first powered flight men had begun to conquer space.

This achievement came to the Doctor's attention very abruptly. Indeed there was almost a nasty accident when, one day in 1957, something whizzed past the Tardis out in space at thousands of miles an hour.

At first the Doctor suspected that here was another piece of Dalek treachery and that his traditional enemies were firing at him with some new weapon.

However he discovered that the object was not a missile, but a man-made object called a satellite which had been launched from Russia and was revolving or orbiting round the earth hundreds of miles up.

This made the Doctor very cross; the Time Lords really should have warned him that he was liable to bump into something in this part of the solar system.

"Very careless," muttered the Doctor grumpily, "I don't know what the Universe is coming to if one can't travel safely."

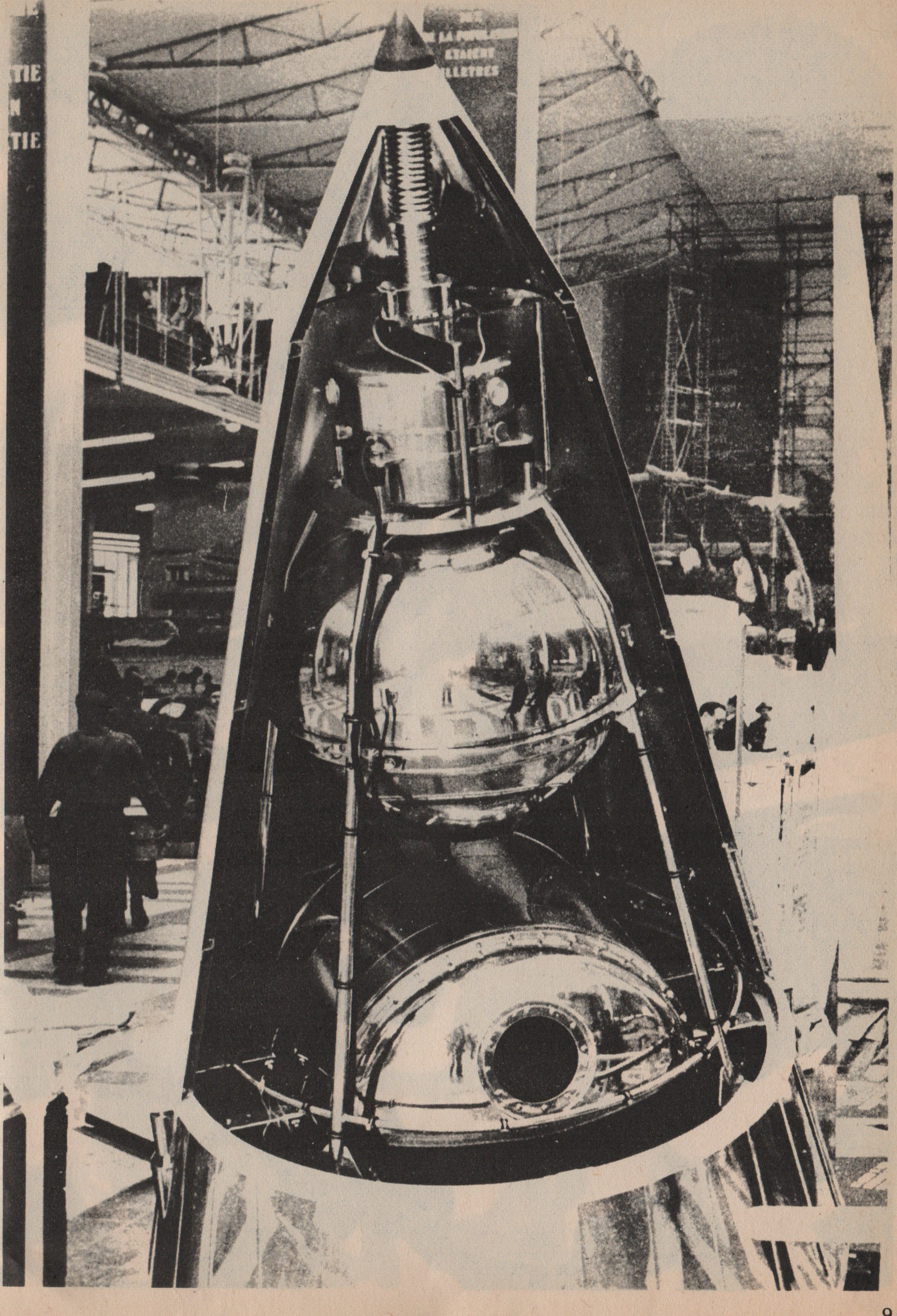
The Doctor decided that the best thing he could do was keep a close watch on this new activity, and make sure he knew exactly what was going on.

Sputnik 2 was the name given to the satellite which almost collided with the Tardis. It was a long cylindrical object with a cone-shaped cabin at one end. Inside a small compartment was the first living creature to be launched into space — a little dog called Laika which was kept alive for a long time by automatic feeding as the capsule circled the earth.

The Sputnik was a triumph for Russia, which now became the first nation in the world with the ability to put a man into space as well.

Russia had been able to develop very powerful rockets, in which she had been helped by some German scientists who had worked on rockets before and during the Second World War.

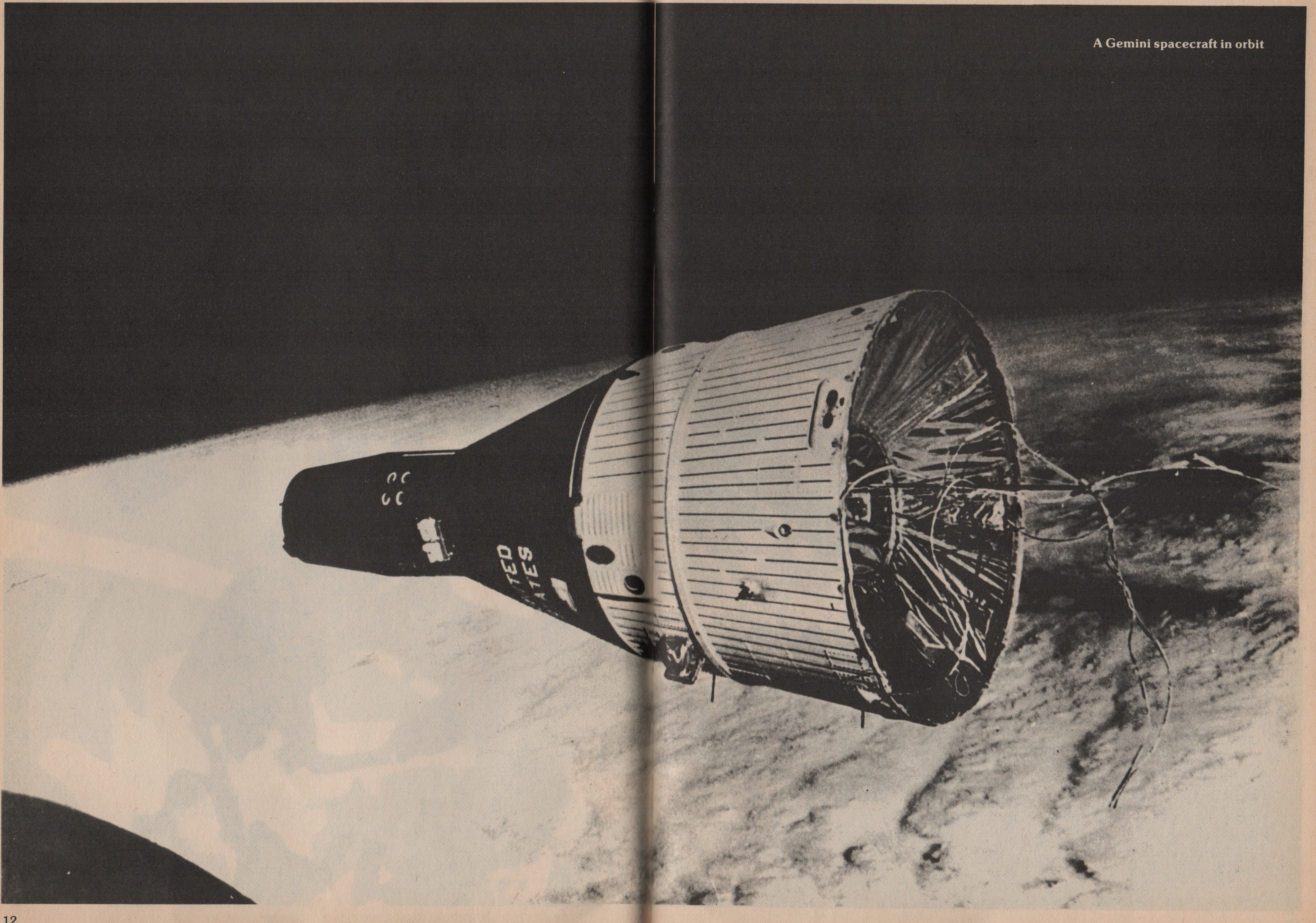
These missiles, like the V1 and the V2, work on a special fuel which burns rapidly and expands into very hot gases when it is ignited. These gases build up in the nose of the rocket and are more powerful than those which are escaping through the exhaust. This 'push', or thrust as it is called, drives the rocket forwards.



Sputnik 2

H.J.P. Arnold

John Glenn, the first American in space



A Gemini spacecraft in orbit

Astronaut Edward White walks in space

In 1961 a Russian cosmonaut, Yuri Gagarin, became the first man in space. His flight lasted just over one and a half hours and he made one complete orbit of the Earth. Over 100 miles up, Yuri Gagarin reported that he felt no ill-effects and his Vostok spaceship landed safely.

Soon the United States began to catch up with Russia and John Glenn repeated the feat of Yuri Gagarin. Her space programme was also led by a brilliant German-born scientist, Wernher von Braun. In 1965, after a series of launches and test orbits, the first American 'walked' in space.

Edward White, wearing a space-suit of 21 layers of insulating material to protect him from the extreme temperatures, opened the hatch of his Gemini craft and propelled himself around for twenty minutes using a 'jet-gun'. His double gold-plated helmet and visor protected his eyes and face against the unfiltered rays of the sun. White was attached to the spacecraft by a 25ft tether which contained his oxygen hose and electrical leads.

American scientists were anxious to know how men reacted to the conditions in space, and the Gemini programme encouraged them to believe that the final objective of the space effort — to land men on other planets and bring them back to Earth — might be possible.

But there were still great problems to be overcome; and the Doctor was sure that men would need much more time before they stood on another planet. All the same, since things had happened rather quickly so far, he decided to pop back to Earth in about 1976 and check on progress.

As usual the Doctor's careful plans went wrong . . . and he found himself having to go back in time for one of the most exciting episodes of space history.

APOLLO MISSION

Several years ago, when the Tardis was having one of its frequent mechanical problems, the Doctor found himself on the Moon. This annoyed him very much, since the Doctor considered it was not the sort of place to which anyone would wish to go.

"The Moon," the Doctor was always saying,"Is very dull and uninteresting. No form of life, no atmosphere, no buried treasures or ancient history."

Even the wonderful view to be had of the Earth, more than 230,000 miles away, was not enough to make the Moon any more attractive to the Doctor.

However on this particular visit the Doctor discovered a number of objects which he had not noticed before. There were several scientific instruments and a strange four-legged contraption covered in aluminium foil with what looked like the top missing! On one of its legs was a plaque which read: "Here men from the planet Earth first set foot upon the Moon July 1969 A.D. We came in peace for all mankind."

The Doctor was astonished by this evidence that members of the human race — for which he had a fond regard but considered still rather primitive — had been able to reach the Moon and, apparently, return safely to Earth.

But what was this curious object with four legs? How did it work? And how had this historic voyage been accomplished? The Doctor always found it difficult to resist trying to find out answers to such intriguing questions. So it was that he determined to trace the story of how man first travelled to the Moon and back to Earth again.

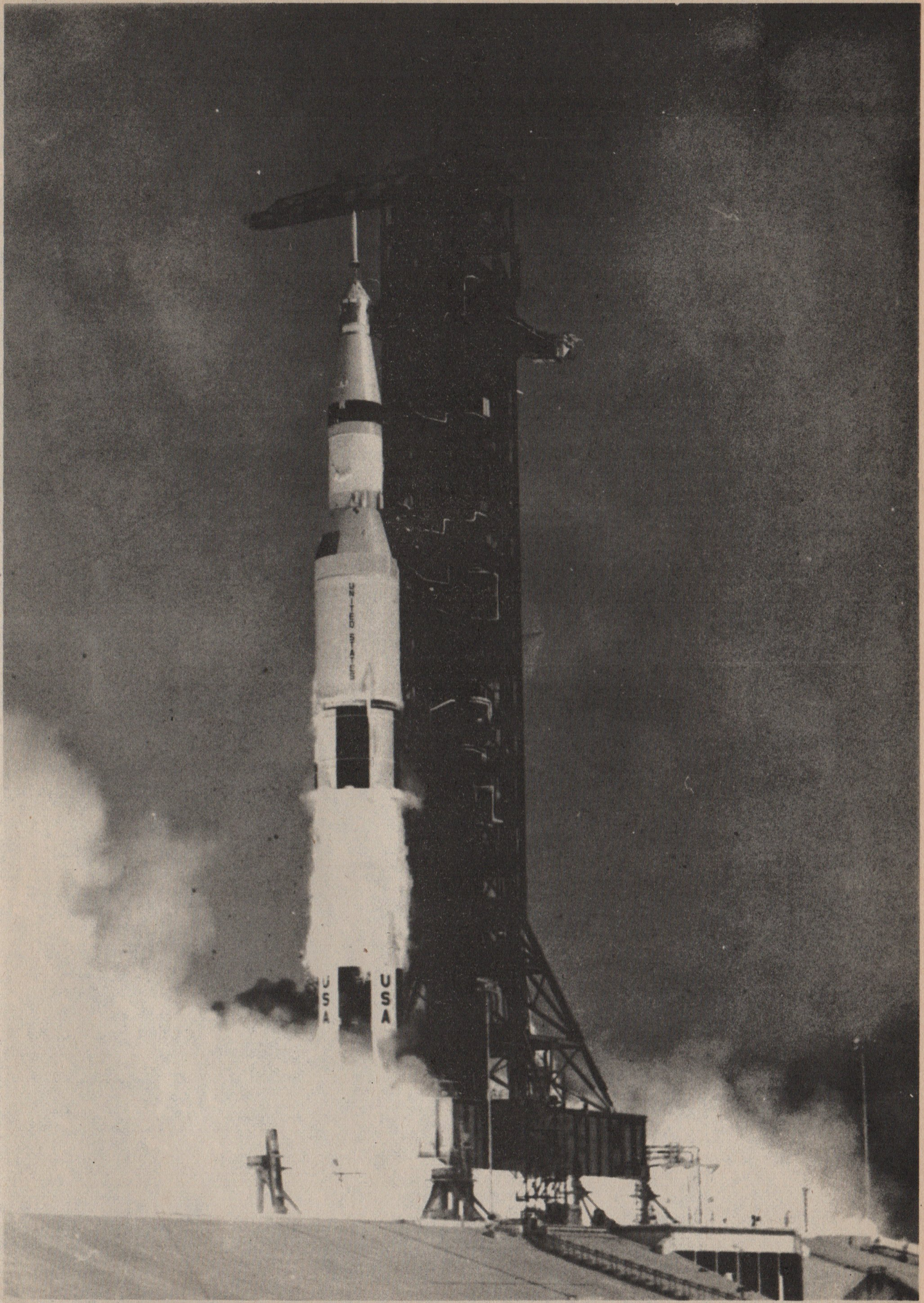
The Tardis hopped back in time, to a day in July 1969. Many thousands of spectators had gathered to watch the lift-off of the giant Saturn V rocket at the Kennedy Space Center in Florida. Perched on top of the rocket, 364ft high, was the Apollo spacecraft. The three astronauts who had been selected to make the flight, Neil Armstrong, Edwin Aldrin and Michael Collins, were already in the capsule. In front of them was a large control panel, on which lights constantly winked on and off as the final checks were made.

This was the climax to many years of research and planning, which began in 1961 when President Kennedy launched Project Apollo and announced that the United States would try to land a man on the Moon.

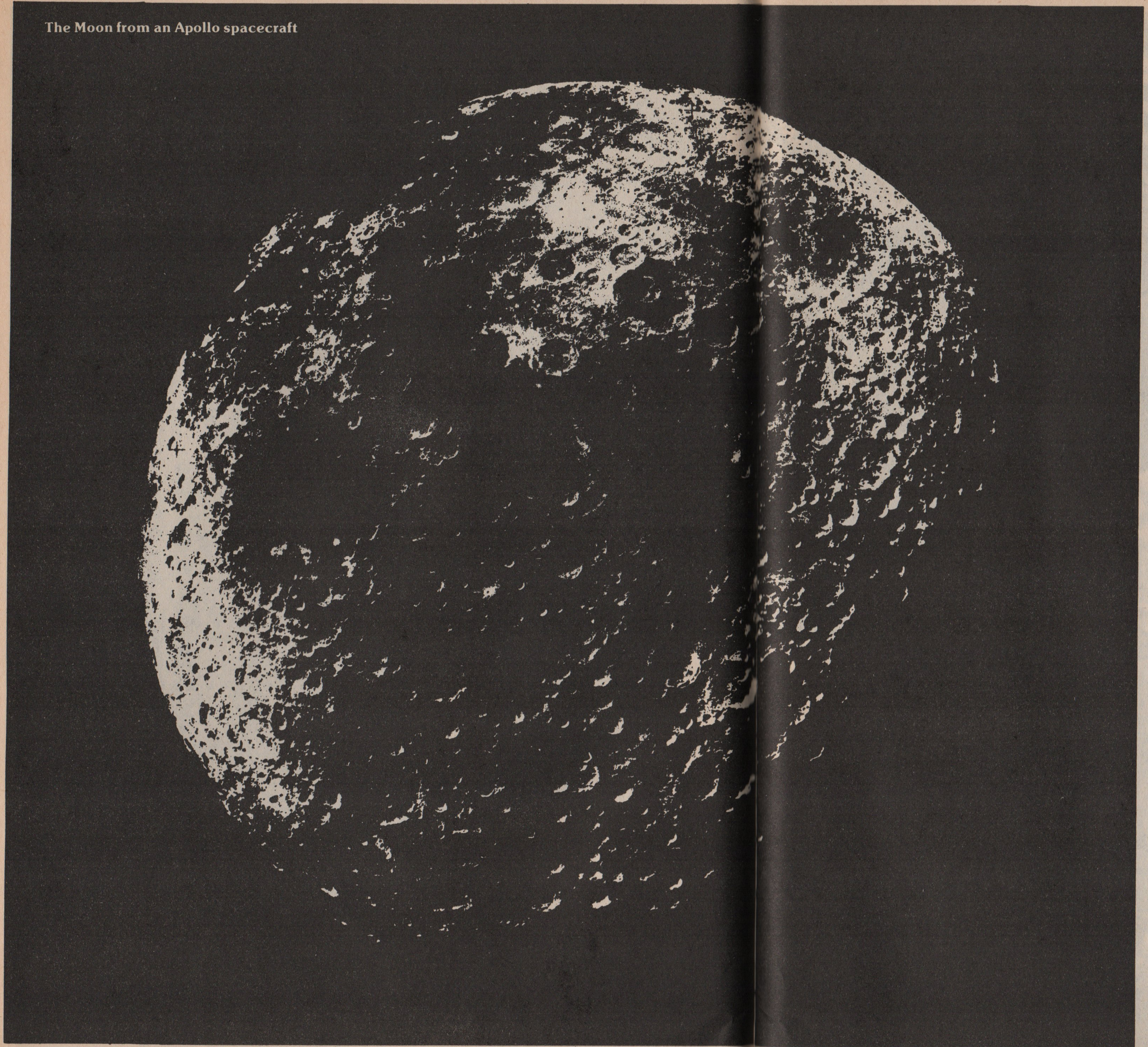
Very powerful engines had been developed capable of lifting the Apollo space-craft, which weighed 50 tons, into space and on its way to the Moon.

The first section, or stage of the rocket, was itself as high as a 14-floor building and its five mighty engines ran on a mixture of kerosene and liquid oxygen fuel. The rocket was so large because it had to carry a vast amount of fuel; its engines burned 40,000 gallons a minute and this first stage would have to fire for between two to three minutes.

While these powerful rocket stages were being designed and developed the Moon itself was being carefully explored. First a series of unmanned space-craft were launched to gather information about the moon and send back photographs. Even the most powerful telescopes on earth were unable to see enough details of the Moon's surface for a smooth and safe landing site to be chosen. The scientists on Earth also wanted to pick sites which would be interesting from a geologic point of view.



The Saturn V lifts off



The Moon from an Apollo spacecraft

The Moon had been the subject of argument for a long time. Was it once part of the Earth? Or was it a body from space which had been 'captured' by Earth's gravity? Information on what the Moon was made of — and it certainly was not cheese — might help to answer these questions.

The first of these robot explorers was Ranger. Ranger was a 'hard-lander' which really meant that it was designed to crash on the Moon's surface, but its six TV cameras were able to transmit pictures back to Earth as it hurtled to its destruction at 5000 mph.

After some early failures the Ranger series provided vital information about the possibility of a moon landing. It showed that there were enough flat areas on the Moon to make safe landing grounds.

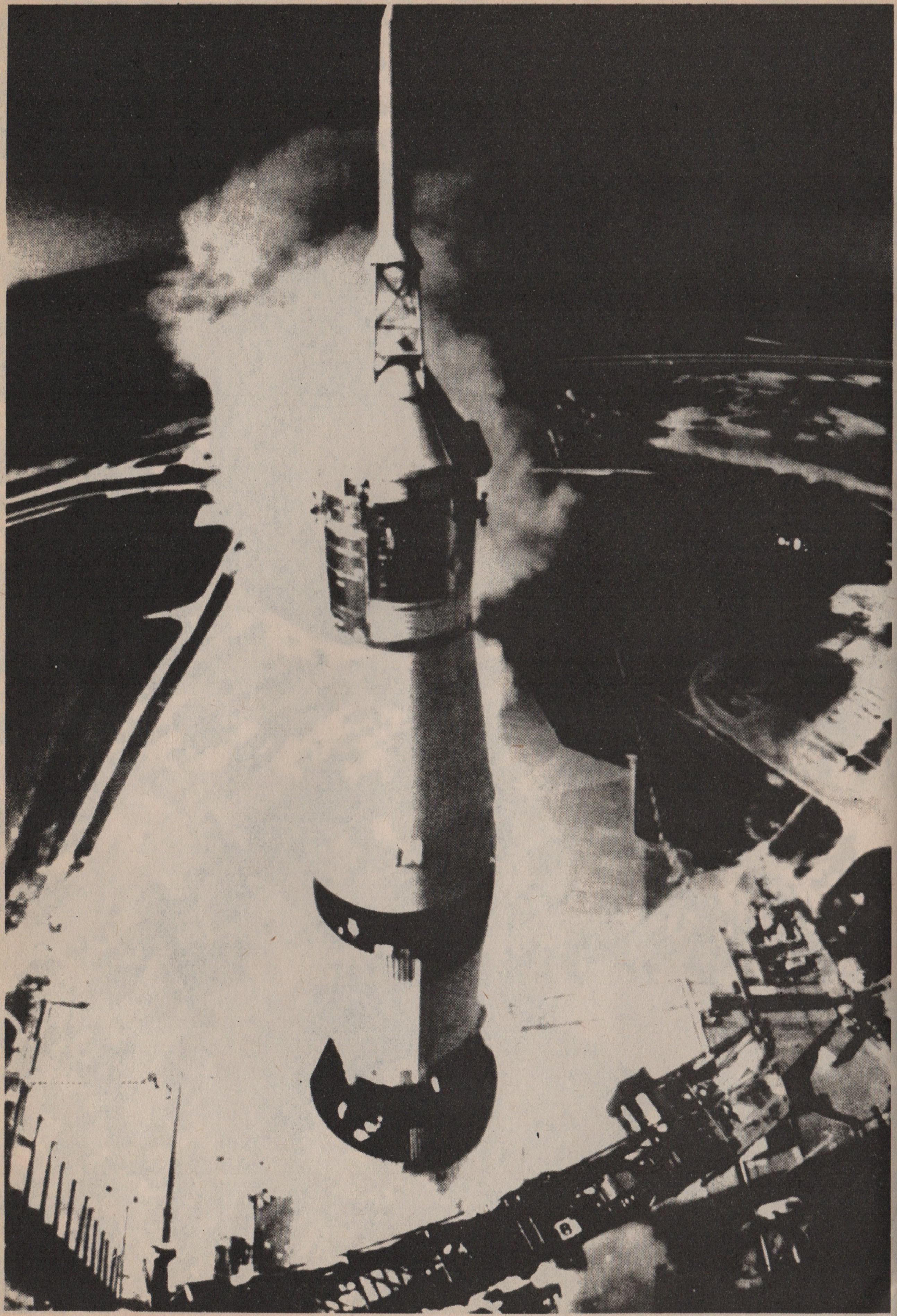
Another question which worried the scientists was the nature of the Moon's surface. There was a theory that the surface of the Moon was covered in a thick layer of dust into which any spacecraft would sink. NASA (National Aeronautics and Space Administration) had to try and find the answer.

Another type of moon explorer was designed called Surveyor. Surveyor was capable of dropping gently onto the surface of the Moon. It was equipped with a single TV camera connected with a rotating mirror. The camera transmitted what it saw in the mirror and in this way the pictures sent back to Earth showed the view all round the robot craft.

The Surveyor also had instruments which could relay information about the Moon's surface material. It sent back reports showing that there was a layer of dust on the Moon, but that it was not deep; and to prove it the Surveyor photographed its own foot-pad showing that it had sunk no more than an inch or two into the surface.

The third type of explorer was Lunar Orbiter, which took close-up photographs as it circled round the Moon. Lunar Orbiter was equipped with a very

Surveyor leaves its footprint



An Apollo launch taken by automatic camera

It was a pity the Doctor had missed this episode of the programme. What an incredible sight it had been as a giant transporter, rumbling along on tank-like tracks at under 1mph, had delivered the entire assembly to the launch pad. The 'crawler' was powered by 16 electric motors and made its 3-mile journey along a specially constructed road as wide as an eight-lane motorway. This road was 7-foot thick in order to withstand the enormous weight put upon it. Once the stack was in position the service gantry, with its five platforms at different levels giving access to the rocket stages and spacecraft modules, was nudged into position alongside.

Inside the Apollo spacecraft the three astronauts prepared for lift-off. They were in the section known as the powerful camera and sent back very detailed pictures of the Moon's surface. Eventually a landing site was picked in the Sea of Tranquility and, thanks to this robot map-making, the astronauts became as familiar with the geography of the Moon as they were with that of the Earth.

By the time the Doctor arrived at the spaceport the Saturn rocket stages and the Apollo spacecraft were already in position on the launch pad. Technicians were making their checks from their positions on the gantry which towered alongside.

Of course these checks had been going on for days and weeks. A great deal of the preparation had been carried out in an enormous hanger three miles from the launch-pad. The Verticle Assembly Building (or VAB) was 418ft high and if it had not been air-conditioned clouds would have formed inside it!

Here the various stages of the rocket had been assembled and each minute part tested by computer, after being shipped by barge to Florida from the manufacturers. As the day of the launch approached the great rockets with the Apollo perched on top was trundled to the launch pad. Command Module, which was the topmost part of what is called 'the stack' — the three rocket stages, the Service Module and then the Command Module.

Compared with the spaciousness of the Tardis it was very cramped! It was 11 foot high, and shaped like a cone. There was a good reason for this, because when the rocket lifted off there would be less resistance to the air with the cone pointing upwards.

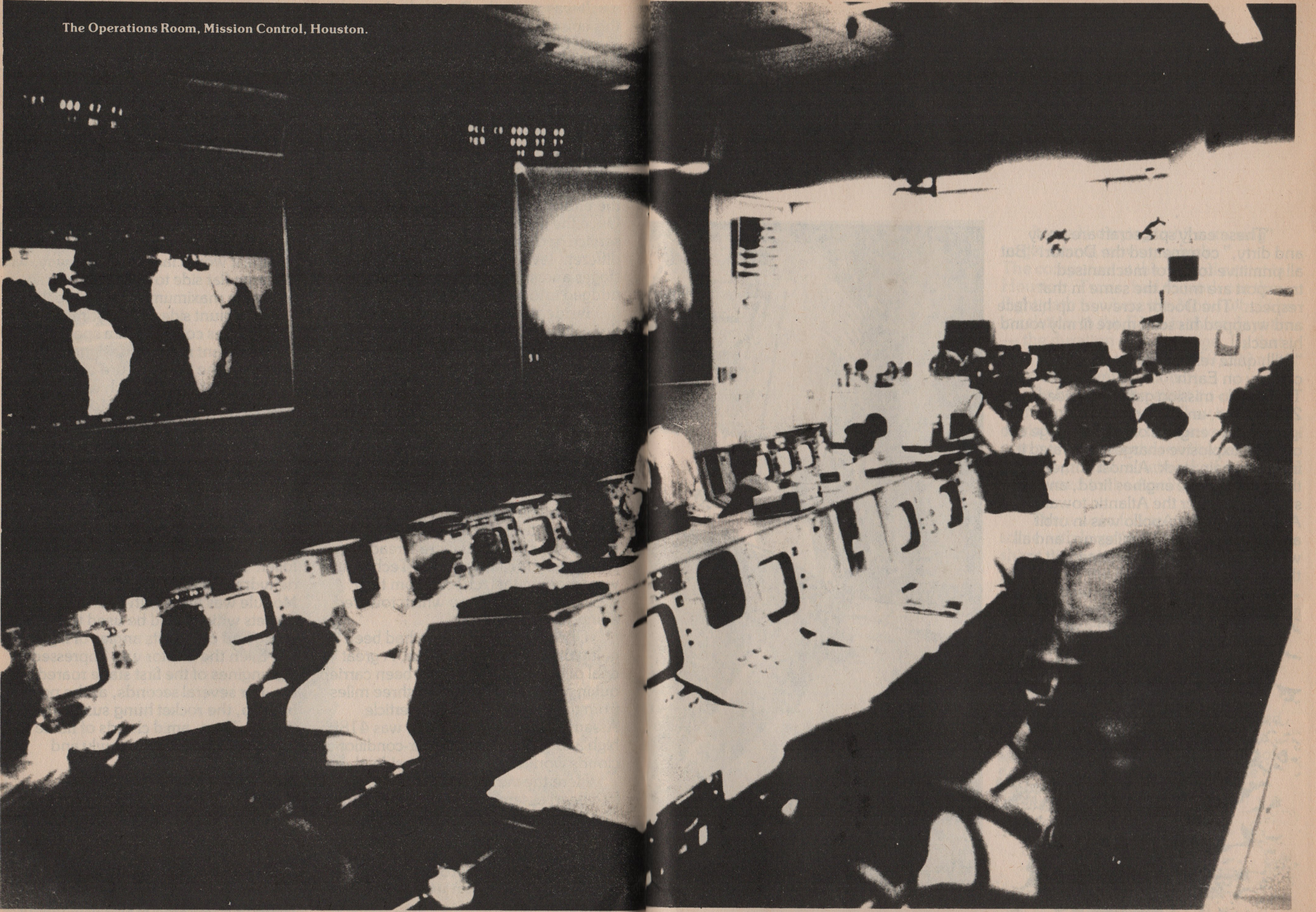
When the capsule returned through the atmosphere, it needed to slow down very quickly. For this final part of the voyage it would face the other way, with the large flat side to the front, and so create the maximum resistance to the air.

This blunt side of the Command Module was coated with a special heat-resistant material designed to withstand the temperature of 5000 degrees Fahrenheit which would be caused by friction as the Module re-entered the Earth's atmosphere. The crew compartment contained three couches onto which the astronauts, wearing their space-suits, had strapped themselves in readiness for the launch.

Built into this quite small space there was also a complete laboratory, a radio and TV station, a kitchen and even a toilet. There was also a 14-day supply of dehydrated food. The Command Module was fitted with twelve small rockets which could be used to steer it in space and control its angles of flight.

Even the Doctor was impressed as the engines of the first stage roared into life. For several seconds, as the power built up, the rocket hung suspended in the air. Then, amid clouds of flame and steam, it began to rise slowly and majestically.

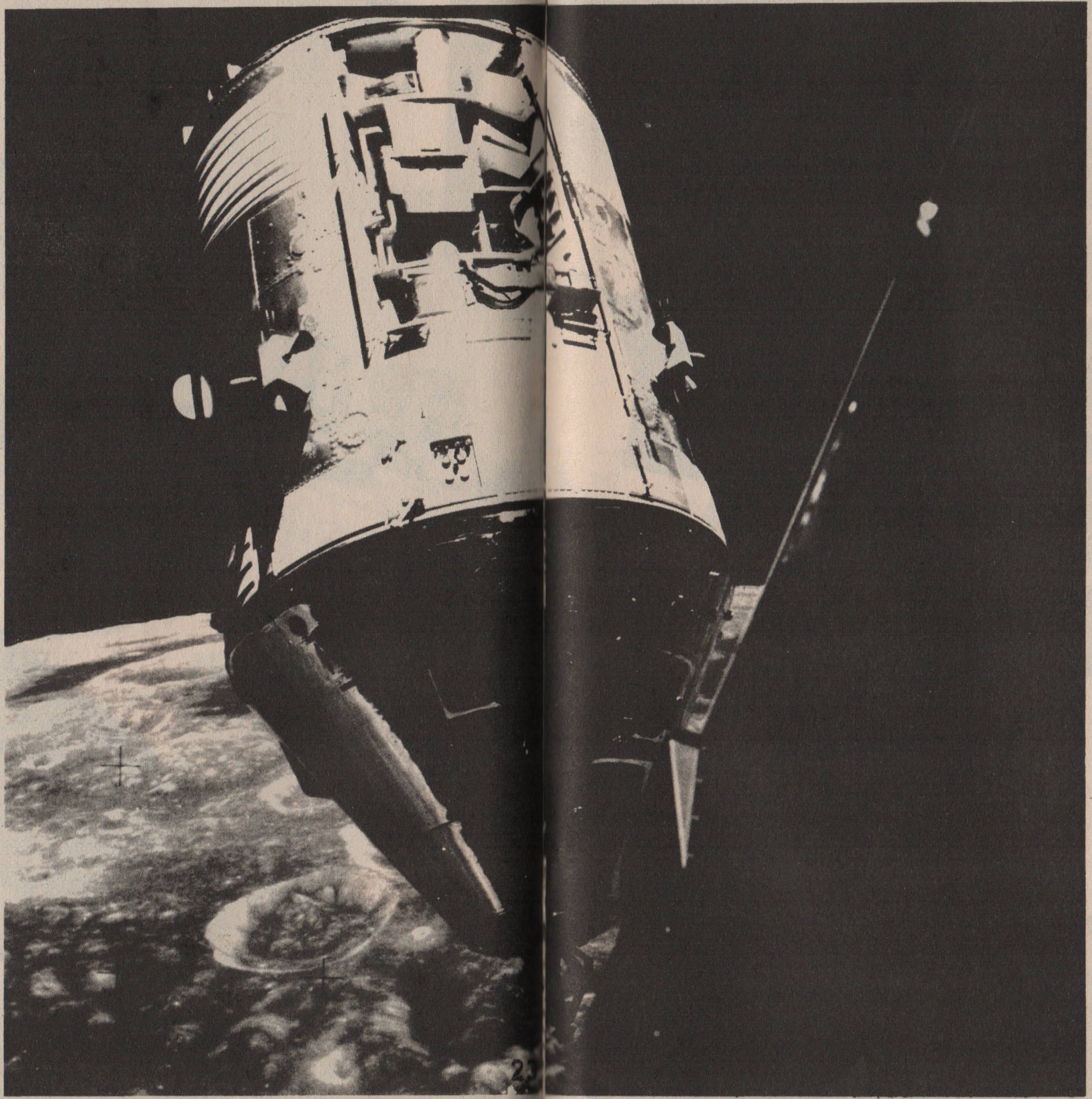
The Operations Room, Mission Control, Houston.



"These early spacecraft are noisy and dirty," commented the Doctor. "But all primitive forms of mechanised transport are much the same in that respect." The Doctor screwed up his face and wrapped his scarf more firmly round his neck.

"Still, quite remarkable for the 20th century on Earth."

The Apollo mission gathered speed. 27 miles up, and 2½ minutes after ignition, the engines of the first stage cut off, and explosive charges separated it from the main stack. Almost immediately, the second stage engines fired, and the stack arced over the Atlantic towards Africa. Soon the Apollo was in orbit around the Earth 117 miles up, and all was ready to 'shoot' the spacecraft to the Moon.



An Apollo docks with a Lunar Module

It was like trying to hit a moving target from a moving vehicle.

The computers at the control center in Houston, Texas, had to work out the flight path to where the Moon would be in relation to the Earth in three days time — the duration of the voyage. By that time the Moon would be 150,000 miles from its present position.

To help plot the exact co-ordinates of the spacecraft, and follow its smallest deviation, and also to ensure good communication between the astronauts and the ground, a network of stations were tuned to the Apollo all around the world.

There were fourteen land-stations, some with large 'dish' receivers, four ships, eight aircraft, all following the progress of the flight.

Because of Apollo's orbital speed and the rotation of the earth each station was in range for only 10-15 minutes so this chain of listening and transmitting posts was essential. Exactly two hours and forty-four minutes after launch a burst was fired from the third stage engine, and with computer-controlled accuracy the Apollo accelerated to a speed of 24,500 mph to take it out of earth orbit on the long 'glide' to the Moon.

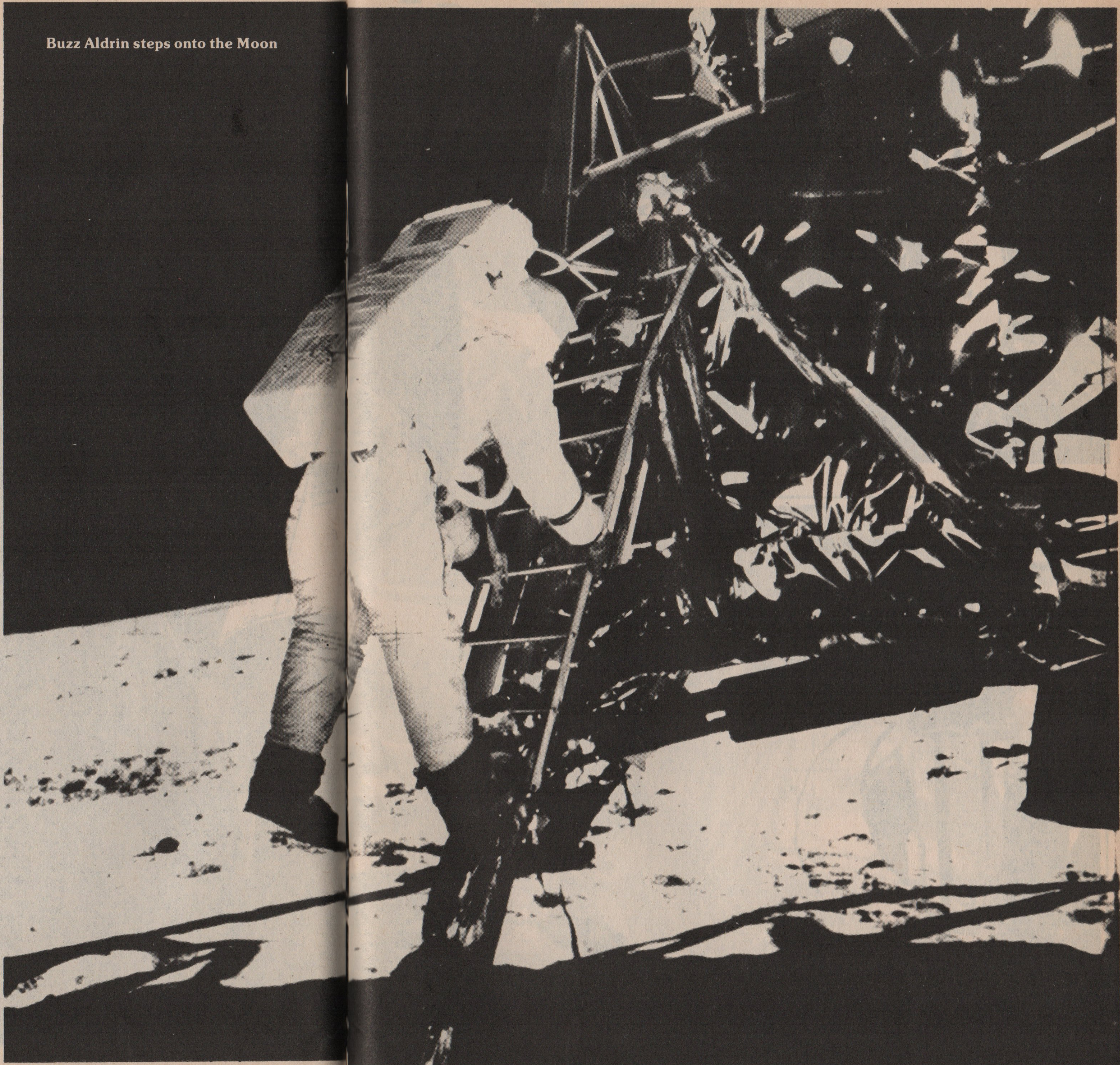
Now the astronauts were able to take off their bulky space-suits and move more freely in the cabin. An automatic system controlled the temperature and pressure. Although it was unlikely that a leak would occur there was always the chance that a minute meteroid might puncture the superstructure. If that did happen the cabin pressure would be automatically increased and allow the astronauts enough time to put their spacesuits back on before the oxygen supply was exhausted.

During the long flight to the Moon the three astronauts had to 're-stack' the Lunar Module—the small spacecraft which would land on the Moon and which was stowed in the third stage of the rocket, behind the Service Module. The protective flaps which had covered the LM during the launch were blown away. The LM, known as Eagle, was pulled from its housing, separated from the Service Module and then 'docked' to the Command Module. Eagle was now attached to the cone of the main spacecraft, its feet pointing away from Apollo. The astronauts could then enter Eagle through a hatch and all was ready for the Moon landing.

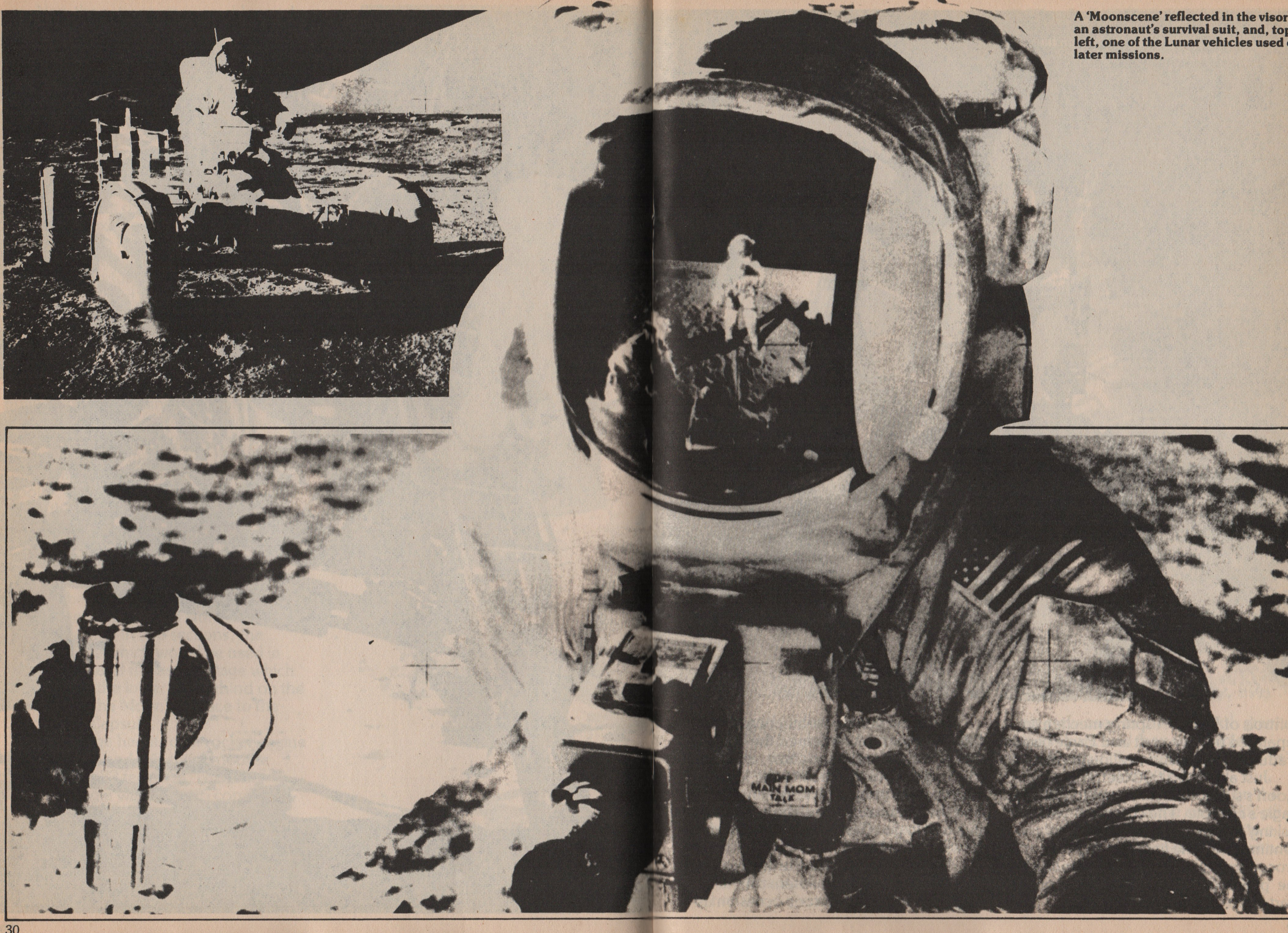
Eagle was a strange-looking craft. Since it did not have to be designed to stand up to the stresses of entering or leaving the earth's atmosphere its sides were paper-thin walls of aluminium foil. It was designed in two sections, the descent stage which would be used in the landing, and the ascent stage which would leave the lower half behind on the return from the Moon's surface to the Command Capsule.

Each stage had its own rocket engine and controls, and the entire module stood nearly 23 feet high. Now the ungainly Eagle was about to come into its own.

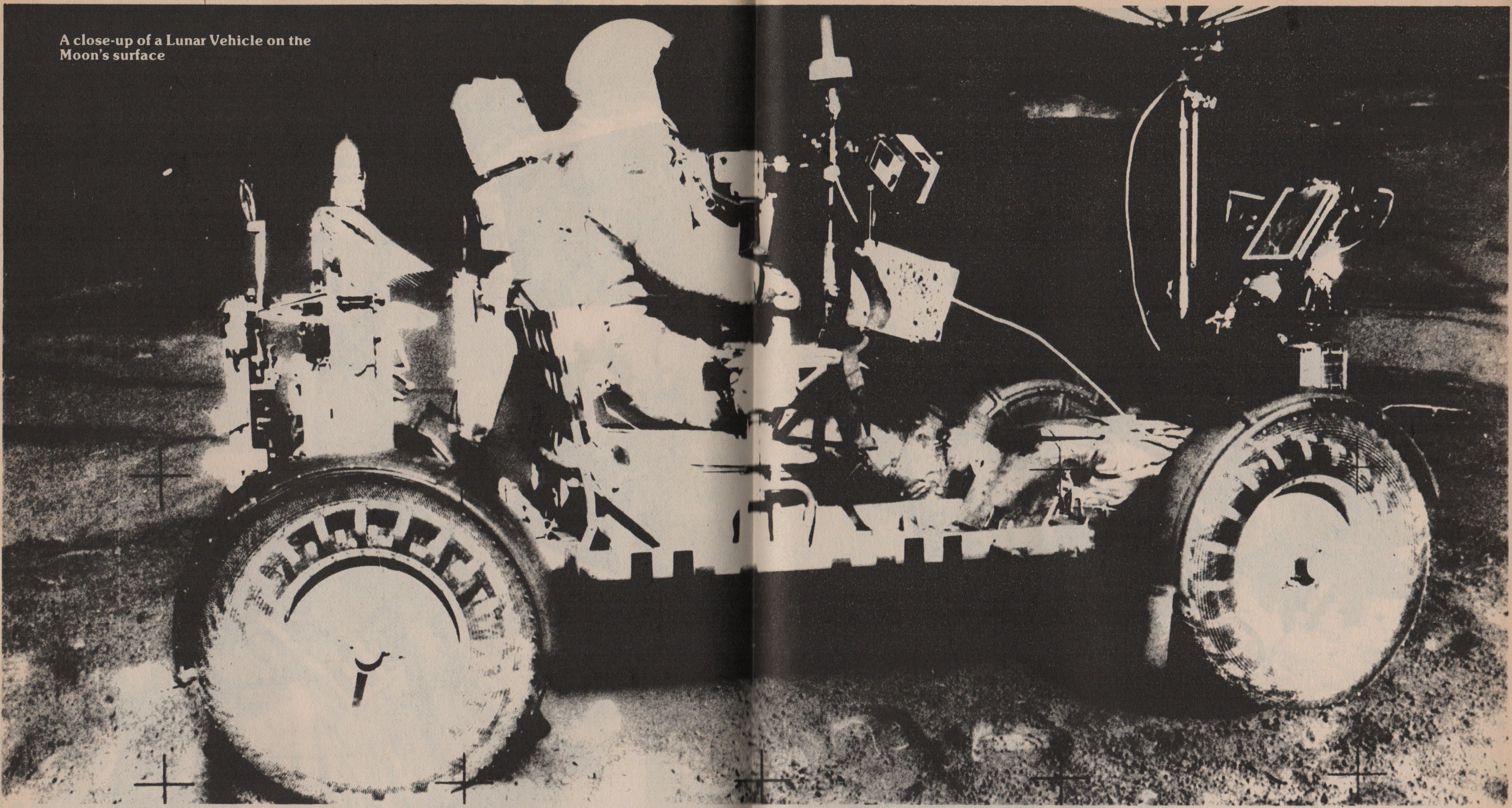
On the fourth day of the voyage, after the Command Module—Columbia—had been manouevred into the right orbit around the Moon, astronauts Armstrong and Aldrin manned the



Buzz Aldrin steps onto the Moon


OFF
MAIN MOM
TALK

A 'Moonscene' reflected in the visor of an astronaut's survival suit, and, top left, one of the Lunar vehicles used on later missions.



A close-up of a Lunar Vehicle on the Moon's surface

controls of Eagle. A spring mechanism separated the two craft and Eagle began gradually to descend to a lower orbit.

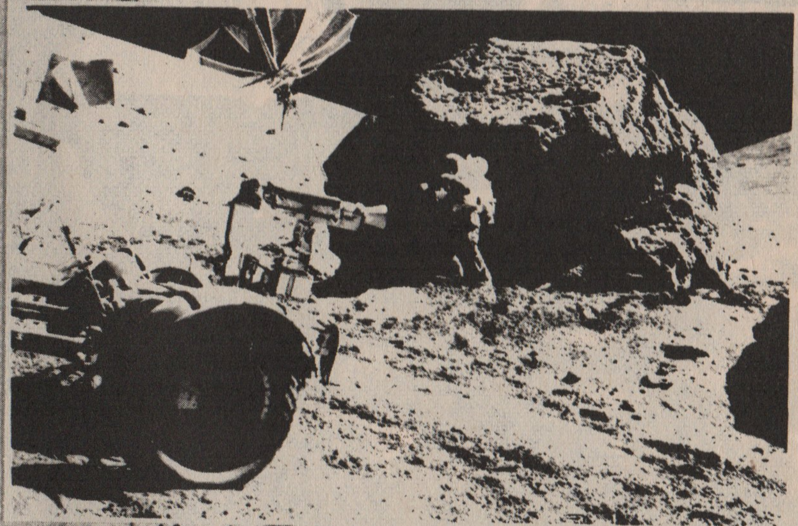
Just above 50,000 feet from the Moon's surface a light began to flash in Eagle's console. The computer was 'asking' the crew if they wanted to continue with the final landing procedures. Neil Armstrong punched the 'proceed' button and the computers started the descent engine.

Feet-first the moon-bug began the final approach. As it neared the surface it tilted into a vertical position, and then the long probes attached to the legs touched the ground. A blue light flashed and the astronauts knew there was only five feet to go. Gently the Eagle touched down on the Moon.

Neil Armstrong was the first man on the Moon. A tiny TV camera on the Eagle recorded the historic occasion as man left his first foot-step on another celestial body. Without wind or weather to erode it, that imprint would be there forever. A few minutes later Edwin Aldrin joined Armstrong on the surface, and together they set up various scientific instruments and collected samples of rock to take back to Earth.

They were surrounded by a strange grey landscape of rocks and craters with the horizon only two miles distant. Both soon grew used to the one-sixth gravity of the Moon, and they were able to move about in their bulky 'life-support' systems without any difficulty.

After a sleep and 24 hours on the Moon it was time for the crucial lift-off. If anything when wrong now the two astronauts would be marooned, without hope of rescue.



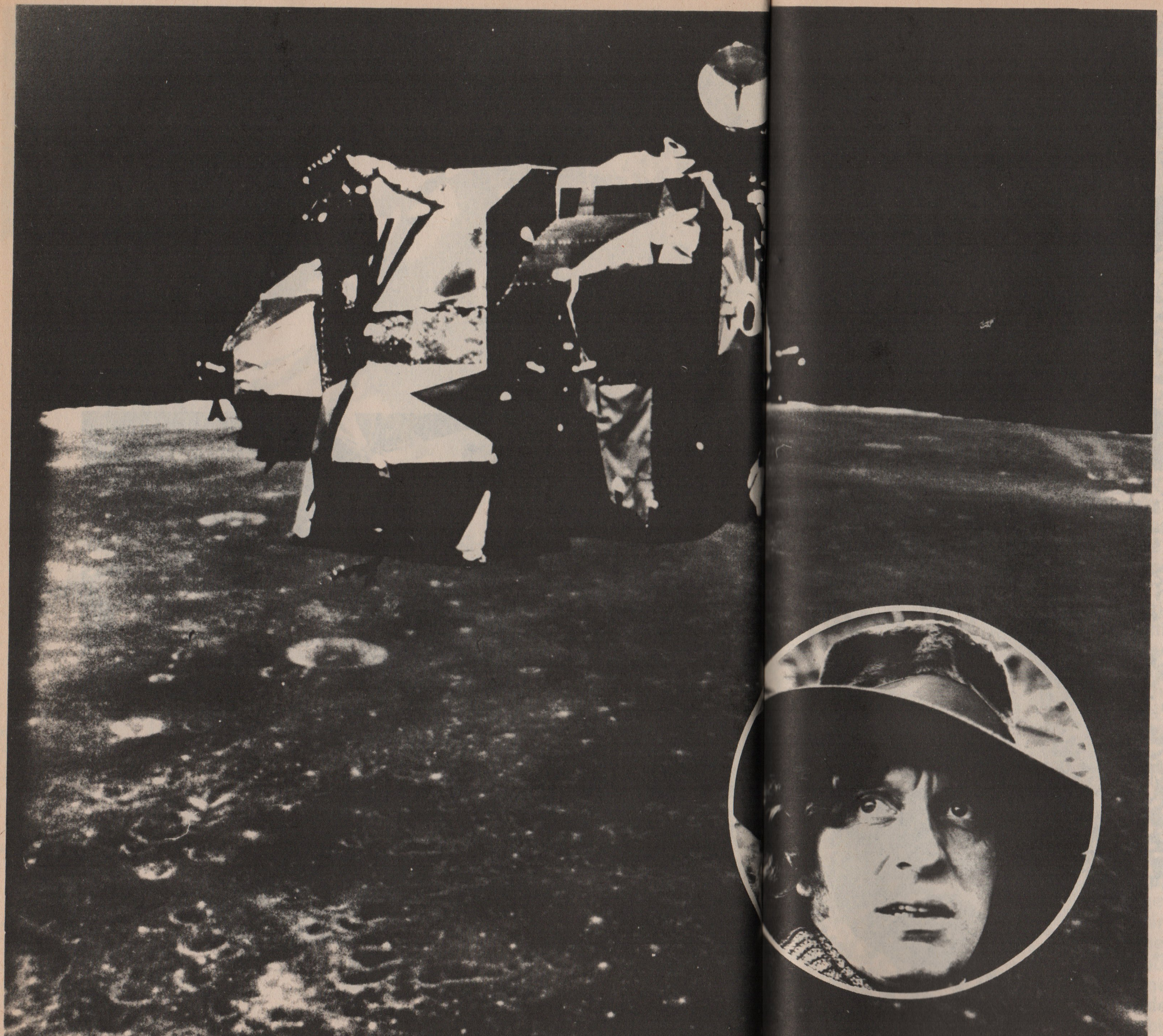
After Apollo II there were more Moon landings and astronauts collected rock samples further afield

Nothing did go wrong. The rocket motor of the ascent stage of Eagle fired perfectly and the Lunar Module docked successfully with Columbia, in which Michael Collins had been orbiting while his two colleagues were on the Moon.

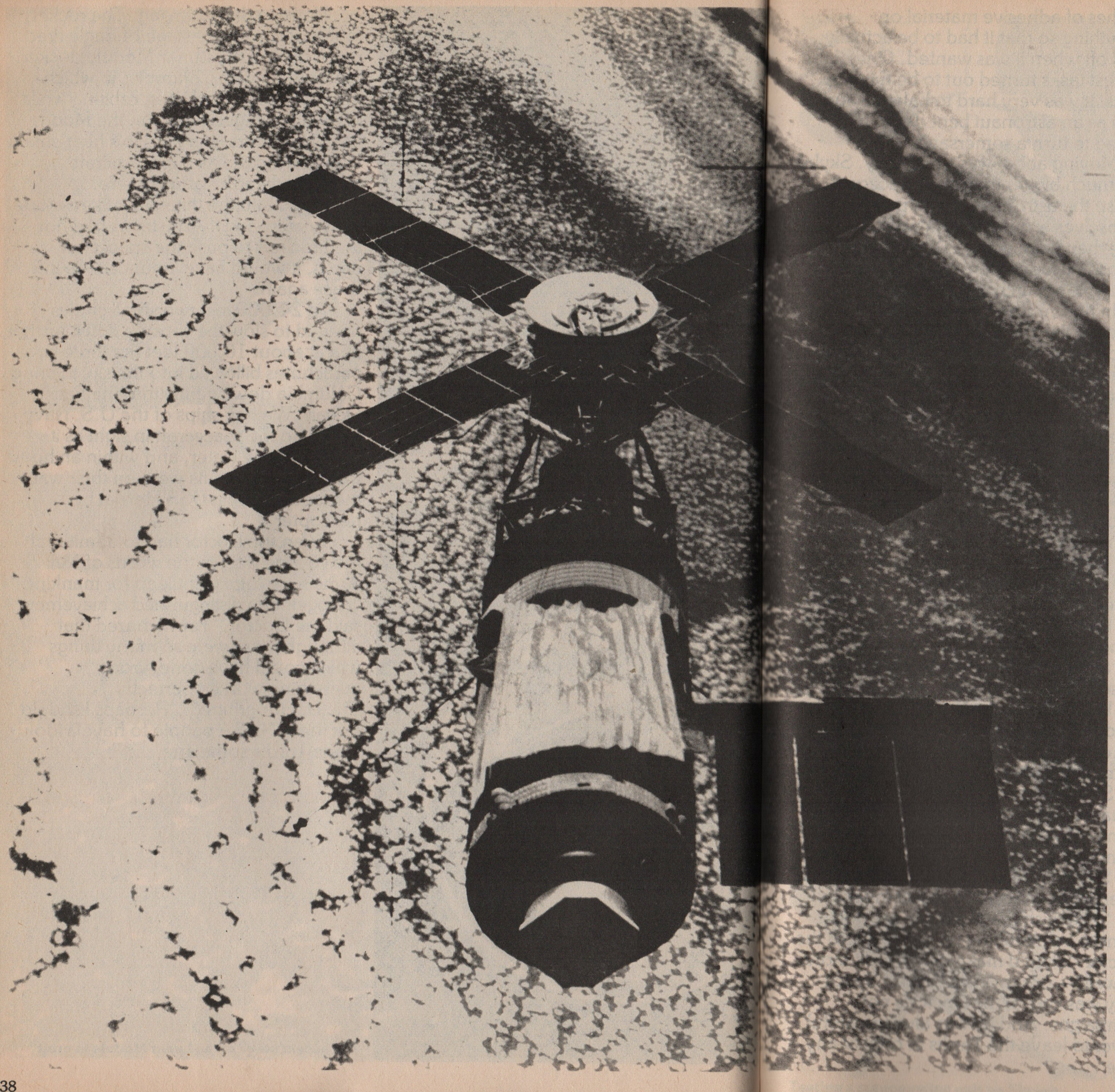
Sixty hours later Apollo's heat-shield was glowing red as the spacecraft re-entered earth's atmosphere.
It skipped into the thicker air like a stone over water, and if Armstrong had not fired rockets to push the spacecraft down, it would have 'bounced' up into space again.

At 24,000 feet two small chutes opened to slow the capsule down further and at about 10,000 feet the three large parachutes billowed into the sky to bring Columbia down gently into the Pacific Ocean. Waiting ships of the U.S. Navy soon had the spacecraft in sight as it bobbed in the water, and within an hour the three astronauts were on their way to the recovery ship USS Hornet by helicopter.

Even the Doctor had to admit that the voyage was, in the words of Neil Armstrong 'one giant leap for mankind.' "Altogether a distinguished achievement," said the Doctor. "I am amazed that although there were so many things which could have gone wrong, everything worked perfectly."
The Doctor grinned: "Perhaps I should ask these NASA people to have a look at the Tardis sometime ....."



The ascent stage of the Lunar Module in orbit



SKYLAB

Before 1973 nobody really knew whether men could stay in space for a long time. The Doctor's body was, of course, specially adapted, and this, together with the very advanced design of the Tardis, meant that he never suffered any ill-effects from his travels.

But for ordinary mortals it was another matter altogether. When the first men in space were carefully examined after spending up to fourteen days in their orbiting capsules the doctors were very concerned.

Because the astronauts were weightless, and floated like fish in the zero gravity of their craft, it was found that many of their muscles grew weak through lack of accustomed exercise. There were other signs too, which seemed to indicate that there would be dangers in staying in space a long time. The astronauts lost calcium from their bones, and red cells from their blood.

So the scientists of NASA were anxious to conduct experiments in putting men in space for periods up to two or three months. One day, in the future, men might want to colonise the planets the way that the first pioneers had conquered the Old West; the Earth might become too crowded, or unable to support the population with sufficient food supplies. Therefore the question of whether men could exist in space was a very important one.

When the Apollo programme came to an end the engineers found a use for some of the equipment. They fixed together a 48-foot long Saturn rocket casing and Apollo capsule, and added other parts; they made a number of modifications, fitted an array of solar panels for generating electricity, and ended up with a 100-ton 'space-station' as big as a three-bedroomed house.

Here, 259 miles over the Earth, teams of astronauts lived and worked for periods up to nearly three months at a time. They performed many scientific experiments and took photographs of the sun's solar flares unhindered by the earth's atmosphere. But one of the most interesting aspects of this house in space — called Skylab — was to see how well its residents coped with living in it for a long time.

Zero gravity may sound like fun but it makes tasks which are simple on earth very difficult and complicated. Even eating turned out to be far from simple!

All the food was dehydrated and water had to be added to the little plastic bags containing the food by squeezing it out of a bottle: nothing can be poured in space and any liquid spilled floats away in a ball!

Quite often these little bags burst, and bits of the meal floated everywhere! The astronauts soon discovered that once they picked up food on a spoon and started lifting it towards their mouths nothing could stop it. If they put the spoon down for some reason the food just kept on coming, and many an astronaut finished up with egg on his face! So they had to be very careful to balance the food on the spoon and transfer it smoothly into their mouths.

In Skylab the astronauts wore special suits with lots of button-up pockets to contain the various objects they had to carry like pencils, scissors, pen-lights and check-lists. Once a pocket was unbuttoned everything in it floated out — as if the astronaut was always standing upside down. The same kind of thing happened whenever a cupboard was opened — out floated everything in it unless it was held down. Imagine going to the bathroom, opening a cupboard to get a toothbrush, and out floats not only the toothbrush, but also razors, soap, toothpaste and any other object inside!

The astronauts managed to solve this particular problem by putting tiny patches of adhesive material on everything so that it had to be actually lifted off when it was wanted. One of the hardest tasks turned out to be tying up shoes! It was very hard to balance and as soon as an astronaut bent down he started to turn a somersault.

Moving about was quite easy. Skylab was much bigger than any spacecraft and so the astronauts could push themselves around off the walls; but once they were going in a particular direction they couldn't stop unless they were able to catch hold of something.

In theory an astronaut could be marooned if he was motionless in the middle of a spacecraft with nothing to catch hold of because, being weightless, he couldn't move himself!

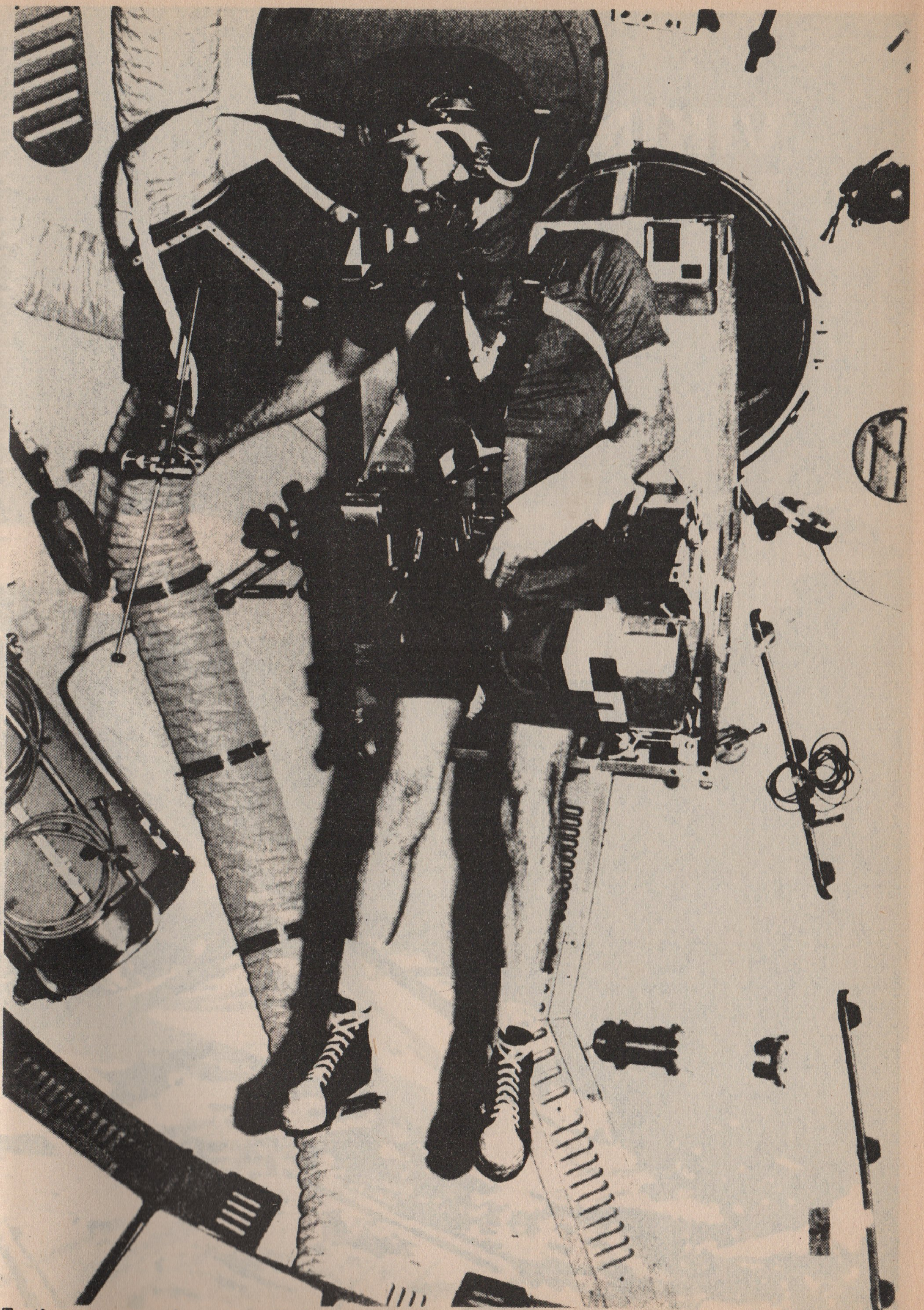
The astronauts on Skylab also experimented with manouevring units; these looked like dentist chairs and were powered by tiny jets of nitrogen gas. The passenger in this strange vehicle could control its direction by operating the jets from a panel of controls in front of him.

The third team of astronauts to live in the space-station stayed for almost three months — the longest any man had been in space. To keep themselves fit they pedalled a bicycle machine every day and this helped to prevent their muscles becoming weak.

When they returned to Earth these astronauts were surprisingly fit, and in a few days had recovered completely from their long stay in space. It did seem from the Skylab experiment that man could remain in a weightless condition for many weeks without coming to any permanent harm.

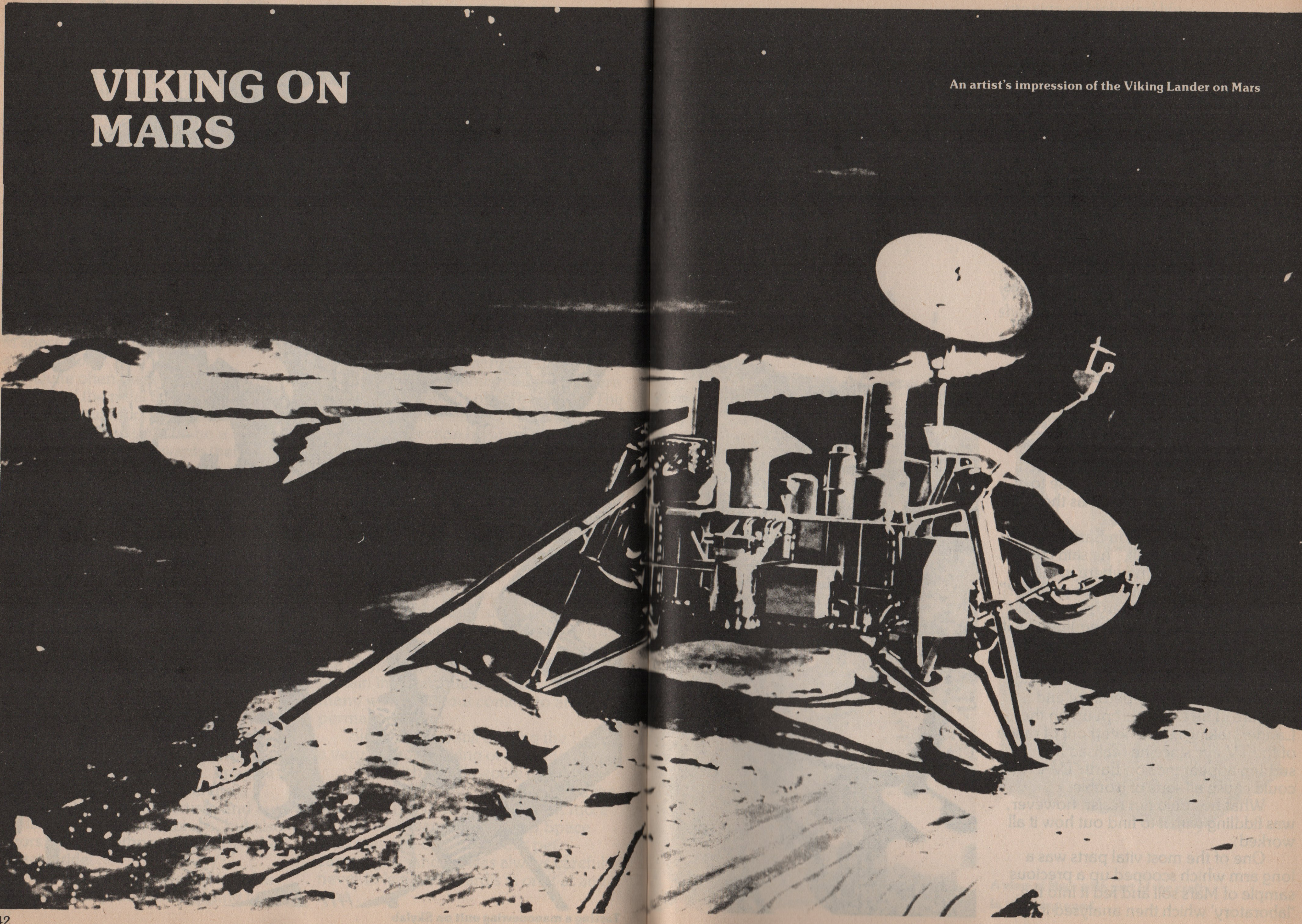
Skylab itself is still orbiting the Earth, a very strange looking object indeed.

"I do wish that if people are going to insist on cluttering up space," said the Doctor "They'd make things look more — well — streamlined." Keep Space Tidy was one of the Doctor's pet campaigns. And he was always careful never to leave the Tardis in orbit at any time . . . .



Testing a manouevring unit on Skylab

VIKING ON MARS



An artist's impression of the Viking Lander on Mars

For many years Mars has been a planet of mystery. Was there any life on it? Were the long straight lines that could be seen through telescopes from Earth great canals built by an advanced civilisation?

In 1976 NASA sent a robot craft more than 200 million miles through space to try and find the answers to these and other questions.

The robot, called Viking, orbited Mars for a month while scientists studied the TV pictures it was sending back in a search for a suitable landing site. Eventually a sufficiently smooth-looking spot was selected and the order for landing was transmitted. Now there was nothing the onlookers at the control centre could do. It takes 19 minutes for radio signals to travel between Earth and Mars so once the Lander — the part of Viking which would touch down on Mars — had separated from the Orbiter there was no way of making any last second corrections.

As always the Doctor was not far from the centre of excitement; indeed this time he came rather too close to it! He happened to be on Mars as the Lander came down.

"Are those people on Earth going to give me no peace at all," he said crossly. "Is there going to be nowhere in the galaxy where I can have some privacy?"

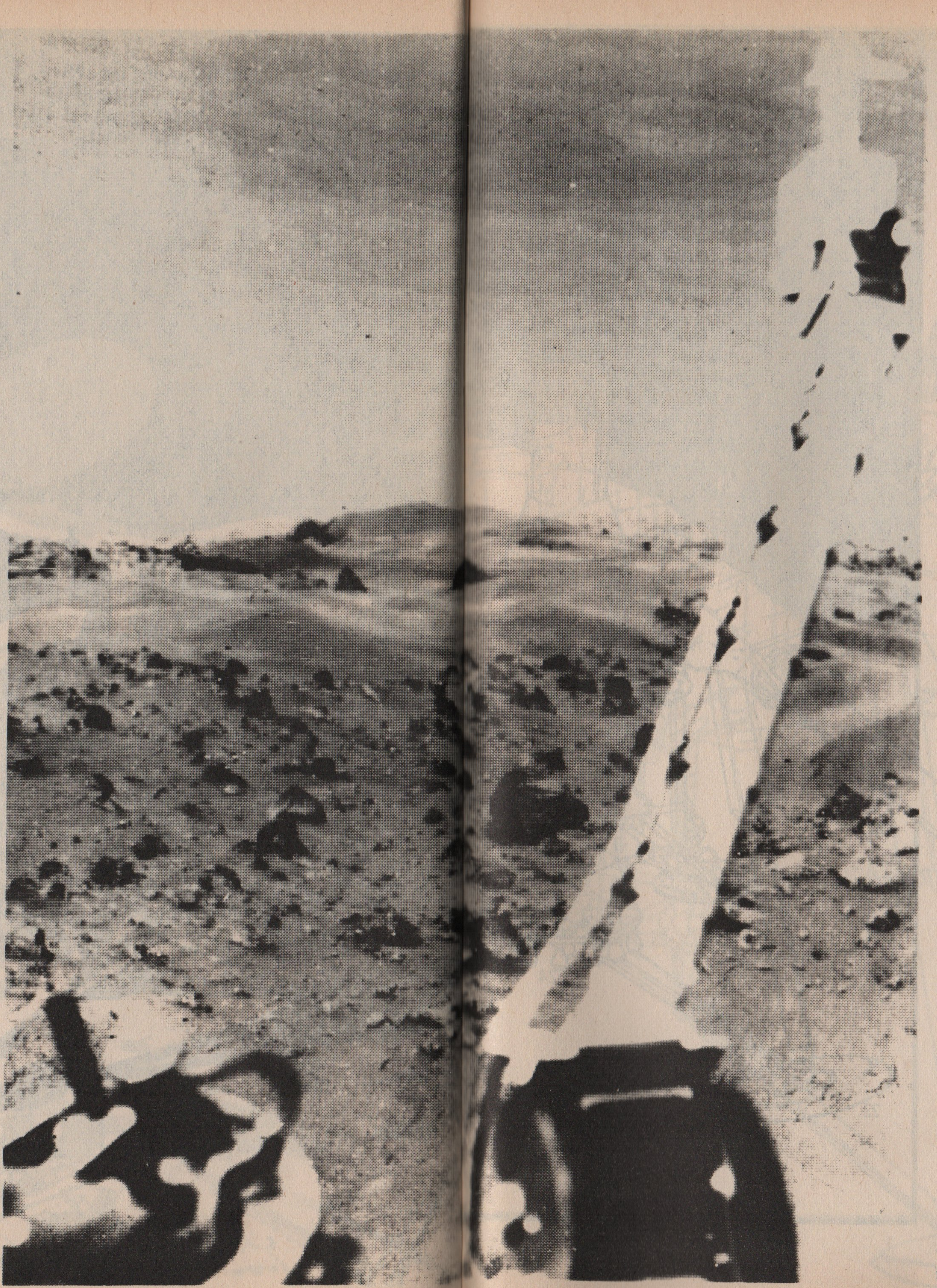
The Lander was a very remarkable piece of machinery. It was equipped with its own miniature laboratories for sampling soil and analysing the atmosphere; and it had instruments for measuring winds, temperature and pressure. The Doctor crept up on the Lander, taking care to keep out of range of the TV eye since he realised his sudden appearance on Earth TV screens could cause all sorts of trouble.

What he could not resist, however, was fiddling with it to find out how it all worked.

One of the most vital parts was a long arm which scooped up a precious sample of Mars soil and fed it into the 'laboratory' which then analysed it for any sign of biological life.

"Ah, most ingenious," said the Doctor. And so it was, but unfortunately the Doctor disturbed the delicate mechanism with the result that when the scientists on Earth gave the command for the arm to pick up its sample it failed to obey. Happily the Doctor had only displaced a small pin and NASA engineers were able to waggle the arm and free it after a few days.

The Lander pictures showed a desert scene with rocks and dunes. Its laboratories found no trace of life in the soil samples. But it does seem that there was once water on Mars, and Viking close-up photographs from orbit show channels in which rivers did flow.

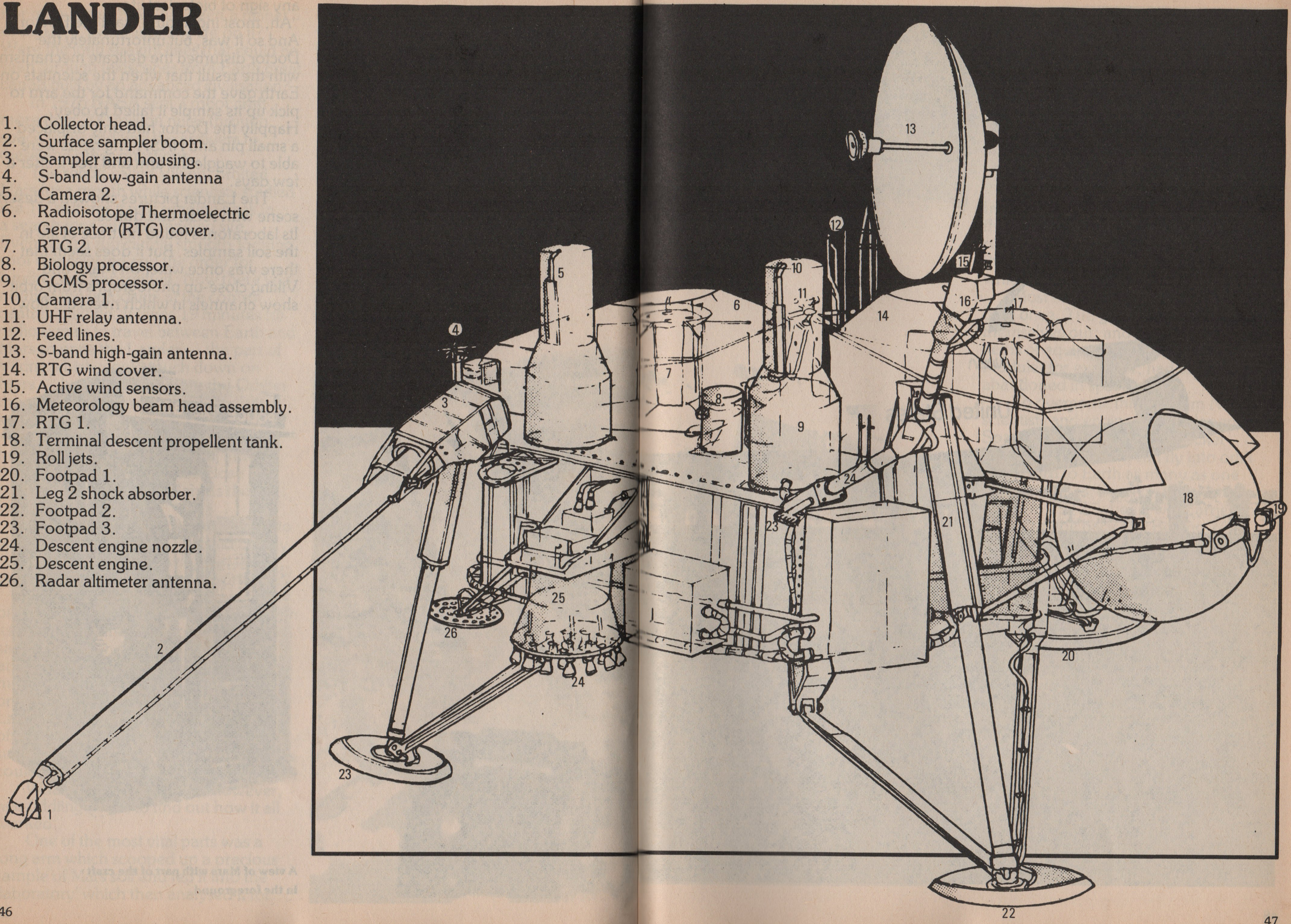


A view of Mars with part of the craft in the foreground

POLICE PUBLIC CALL BOX
POLICE

LANDER

1. Collector head.
2. Surface sampler boom.
3. Sampler arm housing.
4. S-band low-gain antenna
5. Camera 2.
6. Radioisotope Thermoelectric Generator (RTG) cover.
7. RTG 2.
8. Biology processor.
9. GCMS processor.
10. Camera 1.
11. UHF relay antenna.
12. Feed lines.
13. S-band high-gain antenna.
14. RTG wind cover.
15. Active wind sensors.
16. Meteorology beam head assembly.
17. RTG 1.
18. Terminal descent propellent tank.
19. Roll jets.
20. Footpad 1.
21. Leg 2 shock absorber.
22. Footpad 2.
23. Footpad 3.
24. Descent engine nozzle.
25. Descent engine.
26. Radar altimeter antenna.



NASA
United States
En prise

SPACE-SHUTTLE

Imagine how expensive flying would be if, after every trip, an aircraft had to be replaced by a new one! This was exactly the problem with the rocket programmes which launched men into space.

Most of the equipment could be used only once. The great rocket stages burnt themselves out; and many other costly items of equipment, like the Lunar Module, for example, had to be abandoned in space.

To overcome this problem NASA scientists and engineers developed the Space Shuttle, a re-usable rocket powered craft which can fly into orbit and return to Earth as many as one hundred times. Tests on the shuttle began in 1977, when it was carried into the air on the back of a Boeing 747 Jumbo jet and then released to make its own landing.

"A very sensible idea," said the Doctor, who had always thought early space travel equipment very wasteful.

"If people on Earth are going to insist on travelling about in space they will have to find a cheaper way of doing it."

The Doctor promptly hopped into the very economic Tardis and went forward in time to 1985 to see how the shuttle programme had worked out.

The space-port had not changed greatly since the day the Doctor had watched the Apollo II Moon mission lift off. But now an Orbiter shuttle, powered by three engines and two rocket boosters, was taking off.

The NASA space shuttle on the ground

Inside it were its crew of three and four maintenance engineers beginning a two-week orbiting duty roster. Their task was to inspect and maintain communication and weather satellites.

31 miles up the two booster rockets, having done their job, separated from the main craft and landed by parachutes which opened automatically. These boosters could be re-used for the next trip.

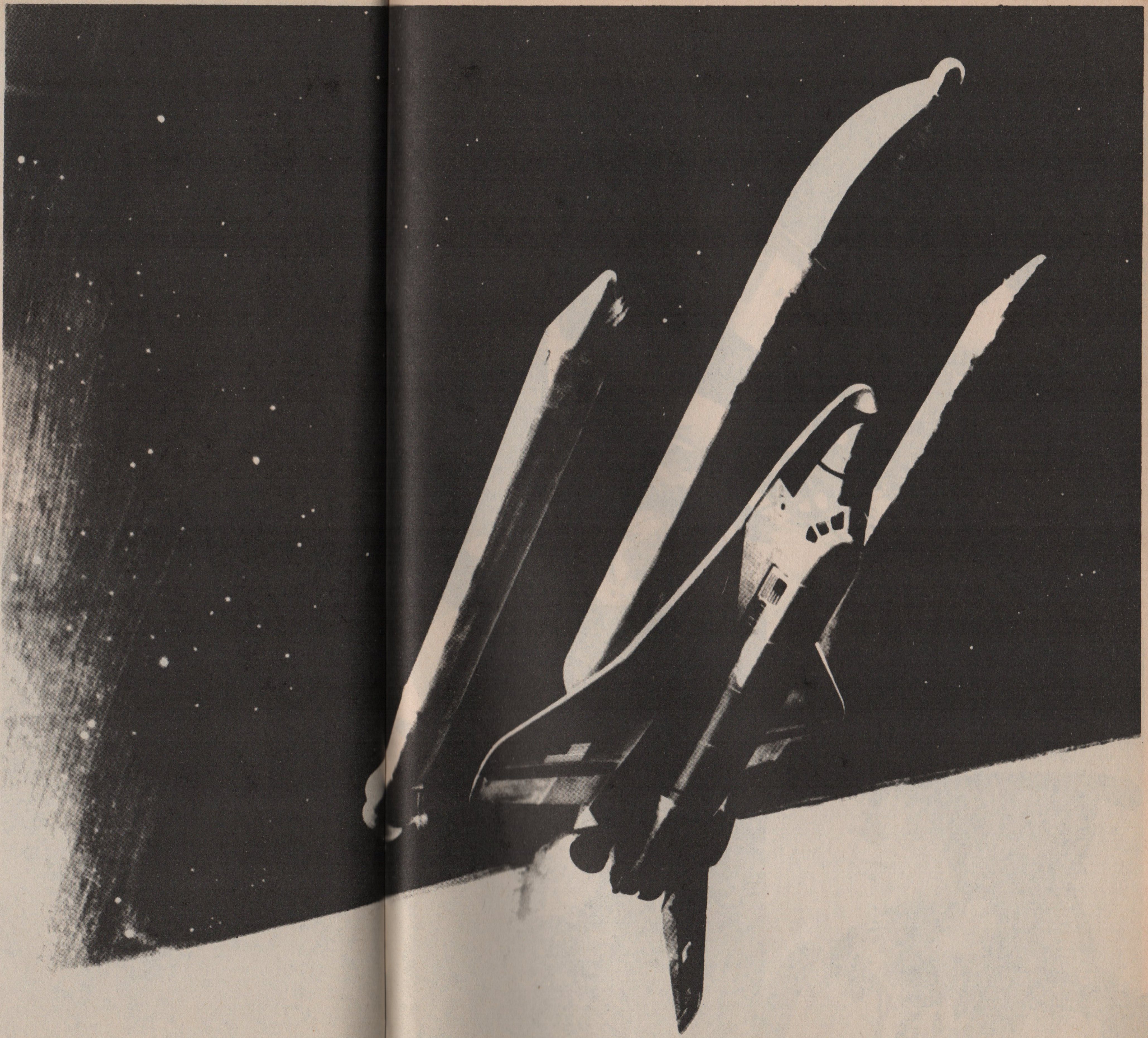
The chain of weather satellites which girdled Earth were vital to the safety of millions of people. From high above the Earth they sent back a stream of TV pictures which enabled meteorologists to chart the course of hurricanes and predict accurately the advent of storms at sea. Aircraft, too, could be informed and if necessary, re-routed.

One such satellite was due to be replaced altogether. Carefully the shuttle pilot manouevred his craft close to it. Next an arm extended automatically to grasp the satellite which was then de-activated by radio command.

Without anyone having to leave the shuttle the satellite was safely stored on board and the arm retracted. The shuttle continued on its mission. The engineers inspected with interest one of the newest satellites. It was an experimental model intended to generate solar power and beam it back to Earth. A large area of solar cells converted the sun's rays into electricity which then beamed the power down to receivers where it was again turned back into electricity.

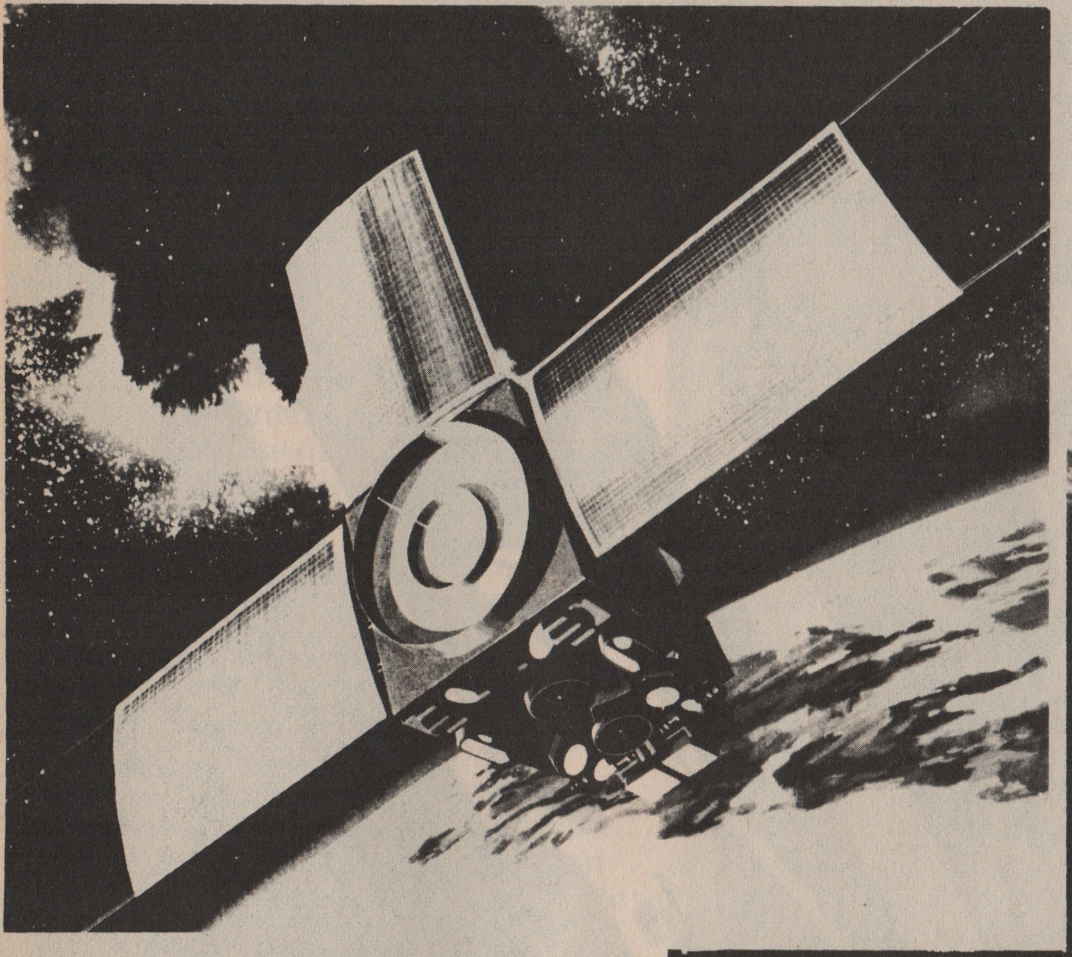
Eventually the shuttle, its tour of duty complete, began its gradual descent. From 17,000 mph the craft's speed slowed as it entered the earth's atmosphere. At 55,000 feet the shuttle went 'subsonic' and began its long controlled glide until it landed on a specially lengthened runway at the space-port at a speed of 220 mph.

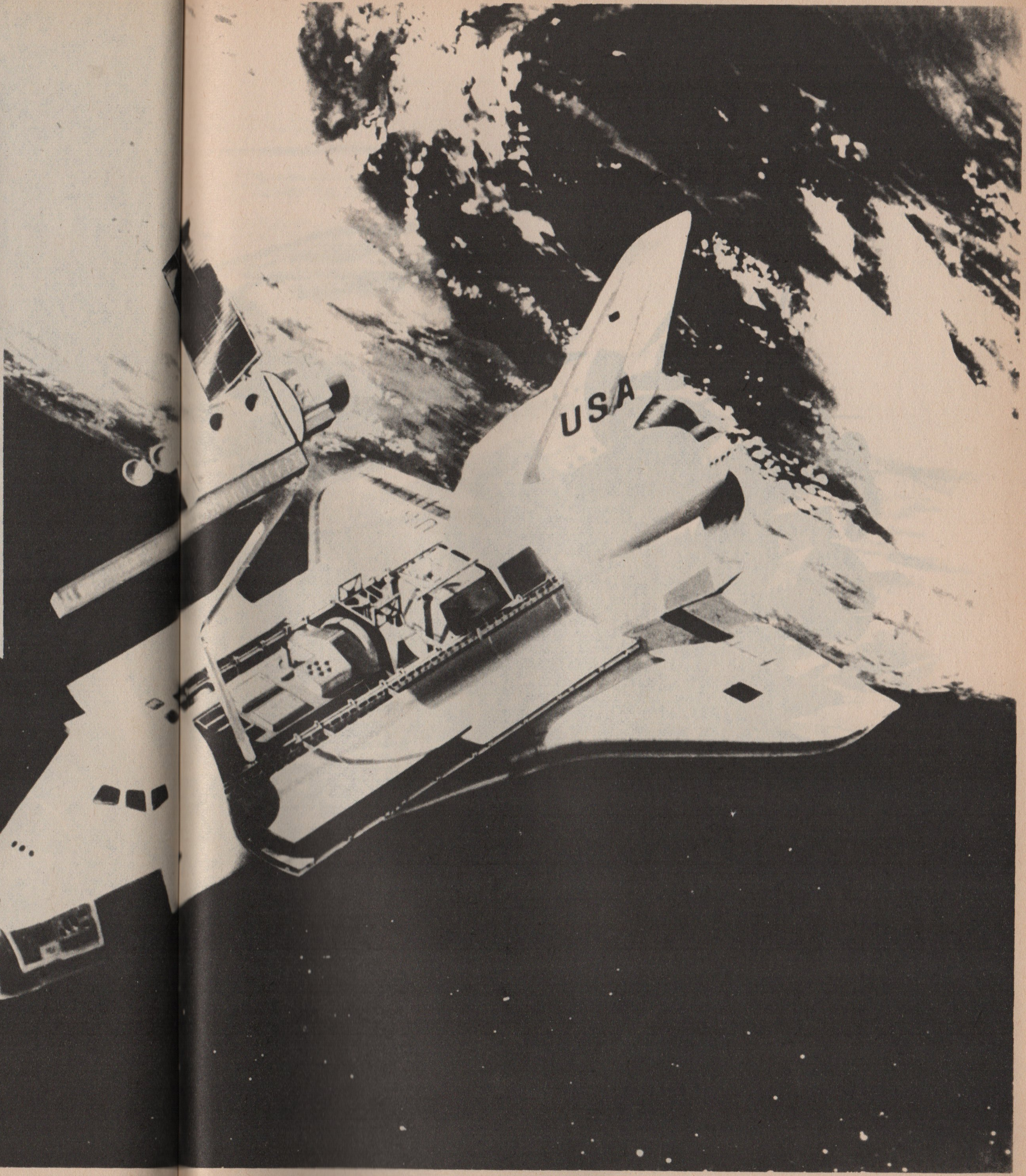
Soon the shuttle was ready for its next trip into space . . . .

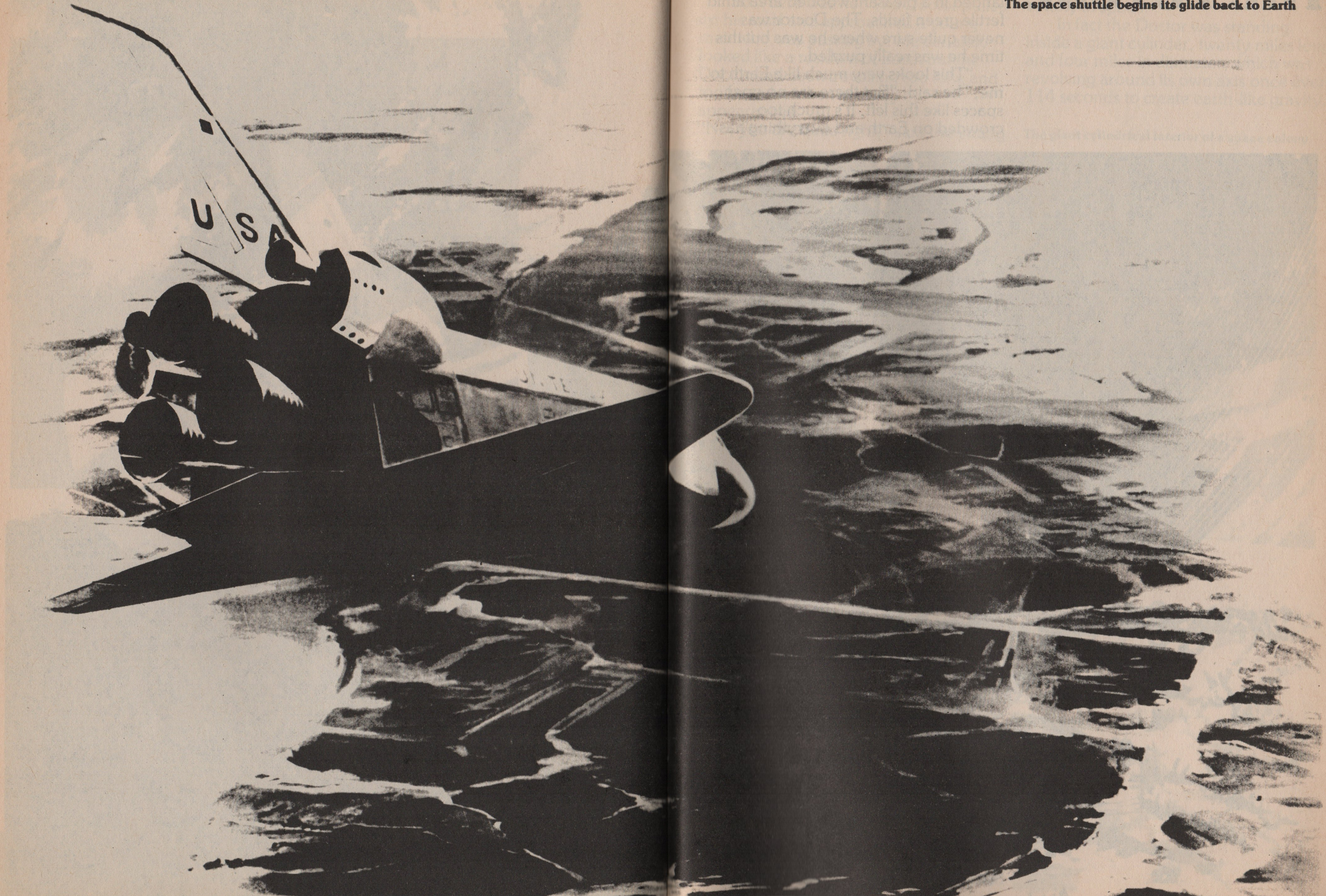


The booster rockets separate from the shuttle

A typical weather satellite and, right, how a space shuttle would service it







The space shuttle begins its glide back to Earth

THE FUTURE

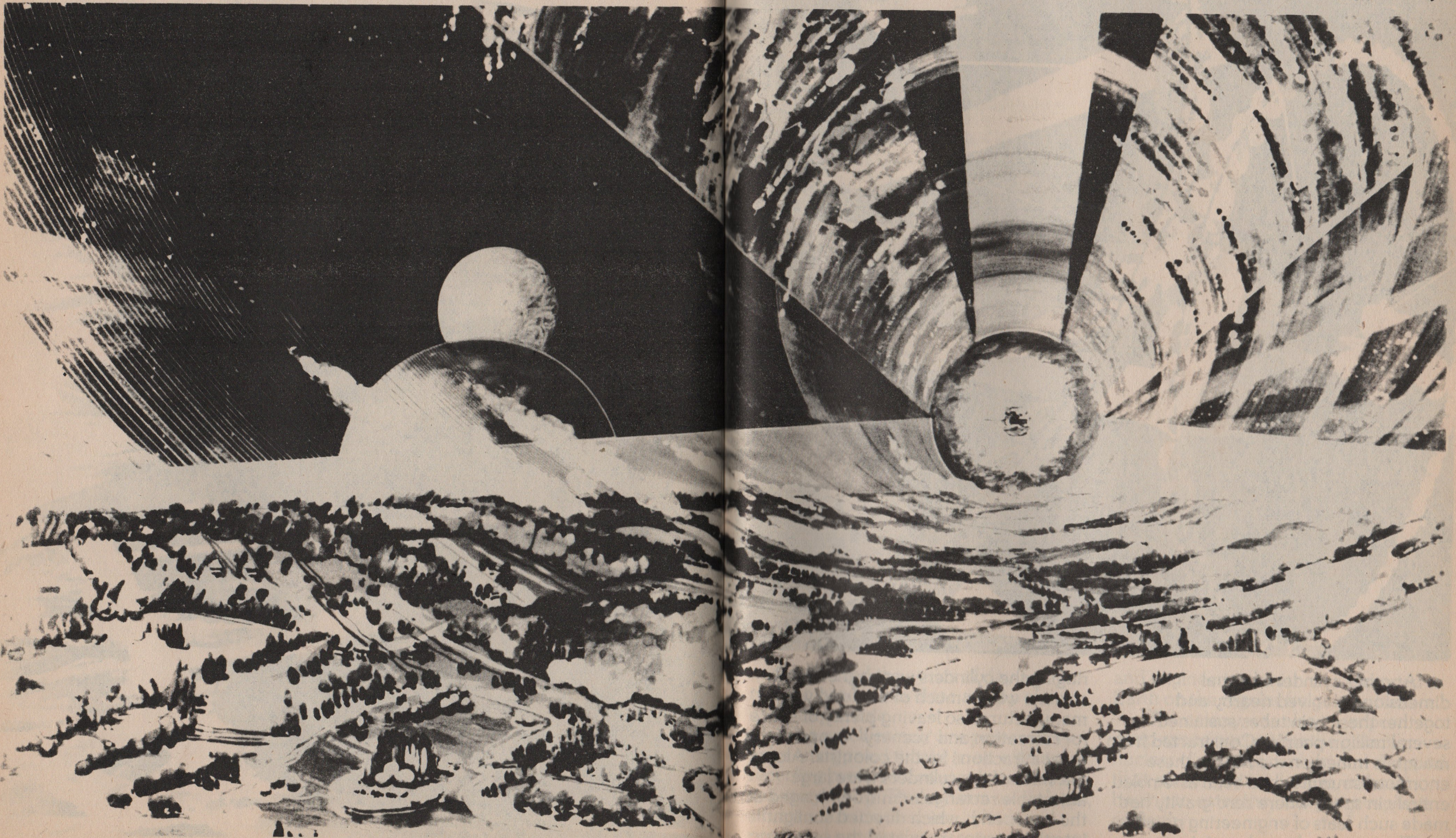
Sometime in the 21st century the Tardis landed in a pleasant wooded area amid fertile green fields. The Doctor was never quite sure where he was but this time he was really puzzled.

"This looks very much like Earth to me," he said. "But there are no open spaces like this left. It's much too crowded on Earth and everything has been given over to growing food."

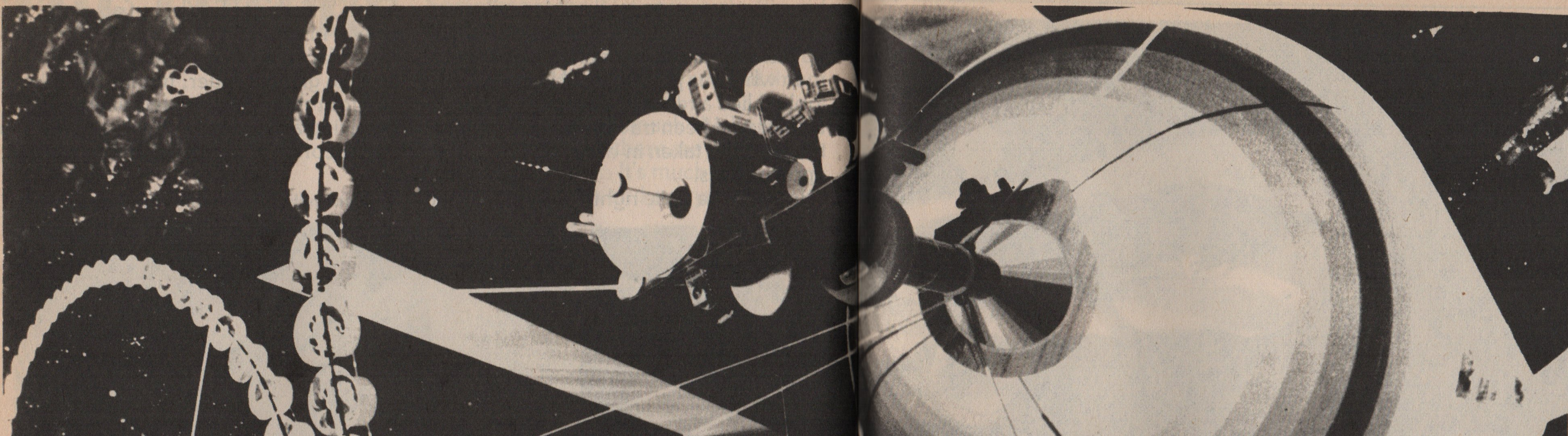
So where was he? The Doctor pulled up his scarf and approached a young man who was passing by. He certainly looked like a resident of Earth but the Doctor had been travelling too long and too far to be taken in easily by appearances.

"No, you are quite right," said the young man. "This is not Earth, but an earth colony in space."

In fact the Doctor was standing inside a giant cylinder, twenty miles long and four miles in diameter, which was revolving around its own axis once every 114 seconds to create earth-like gravity.



The giant cylindrical interior of a space colony



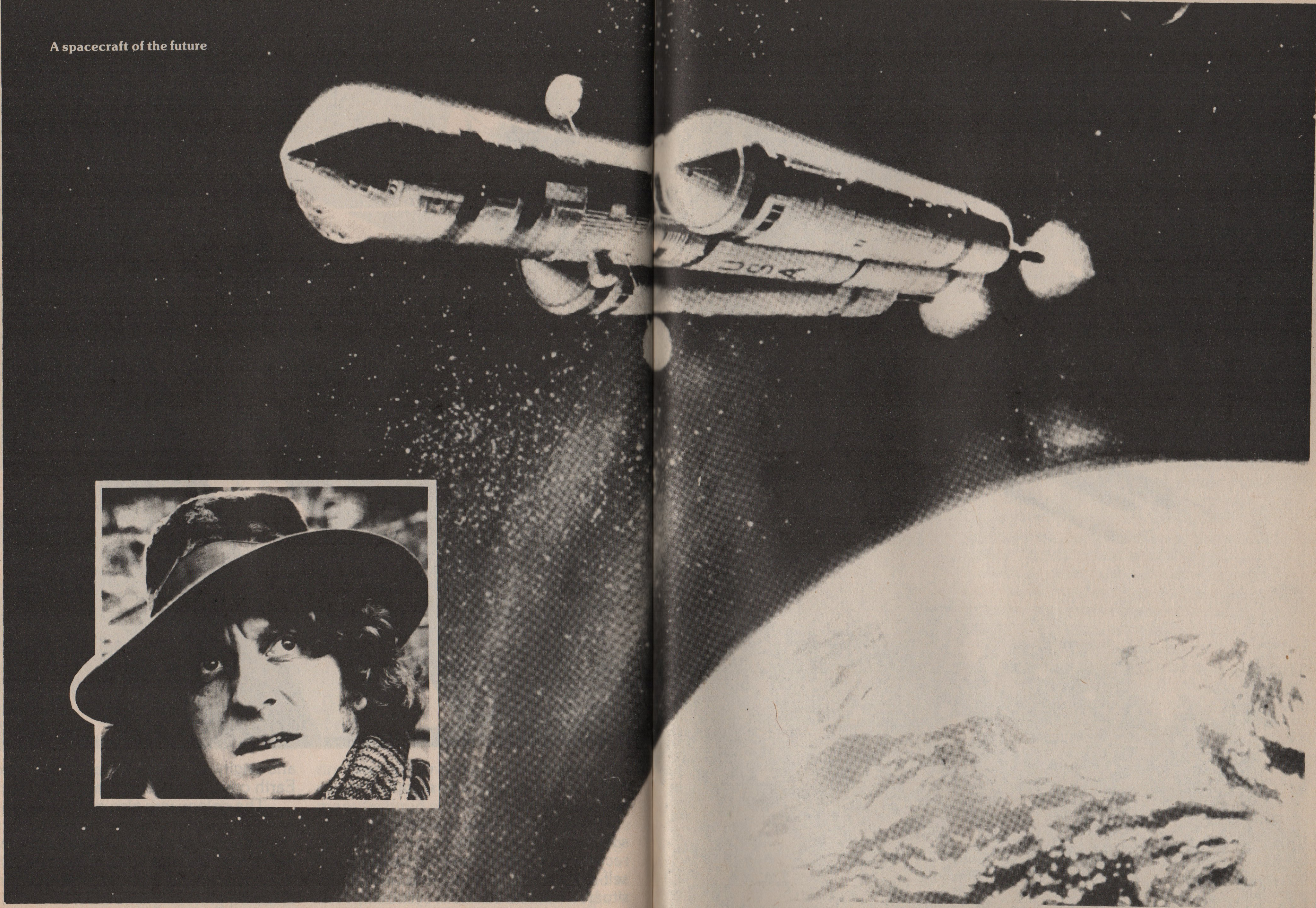
How the space colony would look from 20 miles away

Another cylinder of equal dimensions revolved nearby and together these twin tubes sustained several million people. Constructed from materials mined on the Moon, these enormous structures had been assembled entirely in space where zero gravity had made such feats of engineering possible.

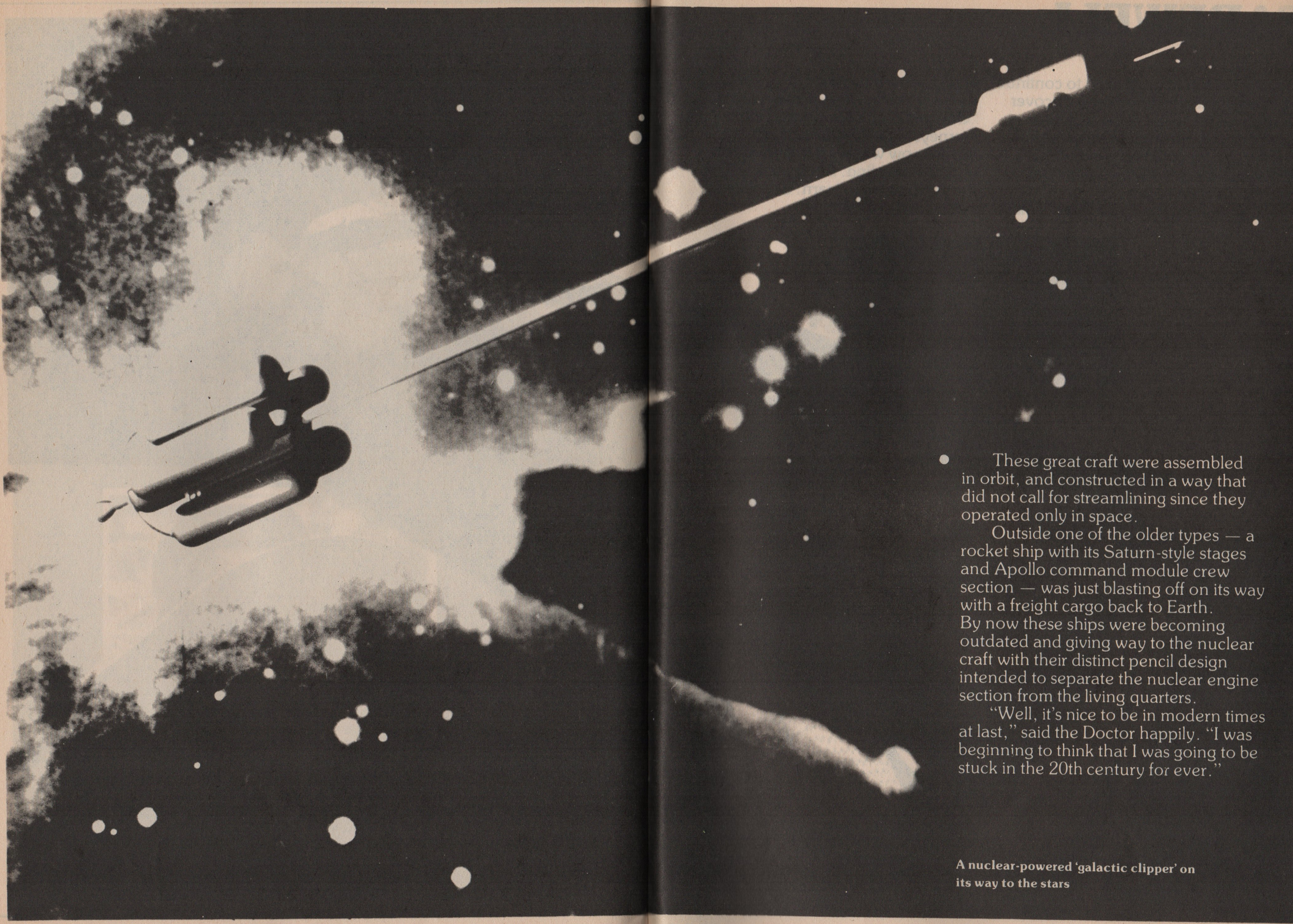
The tea-cup shaped containers ringing the cylinders were agricultural stations where much of the food was manufactured so leaving plenty of space for recreation and 'scenery' — one of the great attractions for the colonists. Along the sides of the cylinders were large adjustable rectangular mirrors, hinged at the lower end, which directed sunlight into the interior, regulated the seasons and controlled the cycles of day and night to produce as close a copy of the earth as possible.

The space colony was powered by solar energy and thanks to an efficient recycling process of wastes, was almost self-supporting. The vacuum workshops, situated outside the main cylinders, produced sensitive electronic equipment and engineering which was exported to Earth on the regular freight shuttles.

The colony was also an import deep-space port where the galactic nuclear clippers picked up and dropped their passengers and cargo without having to enter the heavy atmosphere of Earth.



A spacecraft of the future



● These great craft were assembled in orbit, and constructed in a way that did not call for streamlining since they operated only in space.

Outside one of the older types — a rocket ship with its Saturn-style stages and Apollo command module crew section — was just blasting off on its way with a freight cargo back to Earth. By now these ships were becoming outdated and giving way to the nuclear craft with their distinct pencil design intended to separate the nuclear engine section from the living quarters.

"Well, it's nice to be in modern times at last," said the Doctor happily. "I was beginning to think that I was going to be stuck in the 20th century for ever."

A nuclear-powered 'galactic clipper' on its way to the stars

FAREWELL

The Doctor would have liked to continue his journey into the future and discover more about the world of the 21st century. But there was not time on this occasion and the Doctor could only wonder at what other great feats of engineering men would accomplish.

The Tardis began to oscillate. Where would he turn up next? What would he discover on the voyage now beginning? "One of the nice things about my journeys," said the Doctor, "Is that I never know what exciting places or people I may find. But there's always something new to learn. See you all again soon, Goodbye."

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